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THE APPELLATE COURT OF THE STATE OF NEW YORK AND THE QUESTION OF ALLOWANCES FOR PAVING OVER MAINS IN VALUATION WORK

BY JOHN W. ALVORD

On March 24, 1914, the Court of Appeals of the state of New York handed down its decision in the case of New York Public Service Commission, First District, vs. Kings County Lighting Company, covering three questions of "going concern value," "paving over mains," and the "annual increase in land values."

The writer is in substantial agreement with the decision of the court in the first and last questions, but in its reasoning over the second question, that of paving over mains, there seem to be vital economic and engineering considerations which the court has overlooked.

It is seldom politic or wise to review the decisions of the courts, even when one feels quite sure that the courts have overlooked important matters in their reasoning. Courts have their responsibilities and difficulties; many subjects come before them which are new to them, yet, which they must pass upon, and as a matter of courtesy and propriety, in matters pertaining to law, they are not properly subject to public criticism from the engineer.

But the work of valuing public utilities requires a very considerable knowledge of at least two fields of experience outside of the law, that of engineering and of economics or finance, and when the courts, by reason of their responsibilities, are obliged to reason in these fields, and do not reason from correct economic assumptions, it becomes necessary to considerably point out why practical

engineering experience cannot at times adjust itself to economic ideas of a judicial origin.

In estimating the reproduction of a utility property, the question has been often raised whether the cost of cutting through and replacing paving over mains should be included. It is not a new question and it is submitted, first of all, that it is not a legal question but one involving engineering fact.

Is it physically possible to reduplicate a plant as of today, having a pipe distribution system in the streets in a modern city with pavements all as of today, without cutting through and replacing the paving? A straightforward honest answer to this simple question will relieve us of much trouble and will clear up many difficulties. It is a question which not only the engineer, but the courts can answer promptly and the answer must of necessity be that in all normal cases a humanly possible reduplication of a property cannot be accomplished without incurring those expenses.

Why, then, should this matter trouble valuers? The answer is, first, that nearly everyone unacquainted with the fundamental principles of valuation but charged with its responsibility is confronted with an uncontrollable desire to reason about value before all the evidence of fact is fully complete and before him, and second, that there is always a tendency on the part of inexperienced valuers to mix up evidence on past or investment cost with evidence on reproduction or present day cost, before either are complete.

It will be the endeavor of this review to show that both of these defects clearly exist in the reasoning of the Appellate Court on the question of "Pavement Costs."

SOME FUNDAMENTAL PRINCIPLES

Before proceeding to analyze the opinion of the court, we may, first of all, define the following economic principles, which it is believed are fundamental, and should constantly be kept in mind.

Proposition 1. "*Property*" is seldom the same thing as "*Investment*."

Proposition 2. *Cost* is seldom the same thing as *value*.

Proposition 3. *Past cost* or *investment* is seldom the same thing as *reproduction cost*, or cost new as of today, less depreciation.

Proposition 1. We find that Webster defines property as "The exclusive right of possessing, enjoying, and disposing of a thing; ownership; an estate whether in lands, goods or money."

A property, therefore, may be acquired by gift, by purchase, or by natural accretion. It may grow with the growth of need for its service or it may suffer decline in value because of lessening usefulness.

Webster further defines investment as follows: "The laying out of money in the purchase of some species of property, usually of a permanent nature."

Now, if a given property was purchased say yesterday, the investment may be the same thing as the property, and the amount of the *investment* may also be under some circumstances, a good measure of *value of the property as well*. But if a property was originally built a great many years ago, and was constantly added to since, or perhaps was inherited by gift from outside sources, or had natural accretions in the meantime, or suffered losses of usefulness, then the *investment* is hardly ever the same thing as the property, nor would it be a just and proper measure of value, and this latter condition is the usual and frequent case in valuation work.

In the business world of today, investment is a term used to denote the money actually put into a property, and is not usually considered as measuring the value of the property itself, and Webster's definition seems to substantiate this usage.

In valuation work, therefore, one should be careful not to use the words "Property" and "Investment" interchangeably. They may on rare occasions be identical, but usually they are applied to quite different things.

Proposition 2. *Cost* is seldom the same thing as *value*. *Cost* is only a good index to value when, as has been said, the thing to be valued has been recently purchased under open market conditions likely to be somewhat permanent.

Cost is otherwise not necessarily *value* at all. A thing may be worth much more or much less than it originally cost. It may also be worth much more or much less than it would cost to reproduce it as of today.

Only the briefest kind of thinking is needed to see the truth of this statement.

Proposition 3. Past cost or investment cost is seldom the same thing as reproduction cost, or cost new as of today less depreciation.

The original investment, for instance, may be largely dissipated by bad judgment, a changing popular demand, or a decline of population or other like influences. On the other hand, it may increase

by so-called unearned increments, by gifts, by good judgment, and strategic location, and by the needs of growing population.

The past cost of a plant and the present reproduction cost less depreciation, can only be identical; usually first, when a property has been recently purchased under conditions of market stability and permanency, or, second, when the appreciations and depreciations of the past investment happen by chance to produce a sum which equals reproduction cost less depreciation.

It is believed that these three propositions are self evident. Further light will be thrown on the practical working of these principles by a more detailed discussion of the opinion.

WHAT IS IT THAT WE VALUE

In valuation work it is important to know, first of all, what it is that we are to value. Are we to retrace the actual cash expenditure that has gone into a property, or are we to value the plant and business of the utility as a *property* and as of today? This is not an engineering question; it is the function of the law and the courts to guide us on this important point, and the courts would perform a notable service if they would construe the law on this point for us in a manner so clear and decisive that further discussion of it or dispute about it would be needless. As it is, about one-half the time of courts and commissions is now wasted in hearing opposing views on this particular question from parties, who, for the sake of temporary advantage, desire the one or the other of these views to prevail in their particular case and for their particular side.

So far as engineers can gather the law from a review of court decisions and opinions, the courts are generally holding firmly to the view that it is the *value of the property*, not the past cost, and *as of today*, not as of yesterday or last year, that we are to find; but occasionally a court will wander back to the past investment theory, as the Appellate Court has in part done in this instance, and thus confuse appraisers, engineers and commissions engaged or about to engage in valuation work.

THE FUNCTION OF THE COURT IN REPRODUCTION EVIDENCE

The court has two functions to perform in receiving and reviewing reproduction evidence:

1. It should scrutinize the reproduction estimates in the light of

reason and common sense aided by the engineering evidence to see that they are made on a basis that is humanly possible and practicably feasible and workable; that nothing is left out of them that would ordinarily be encountered in real life and real work, and that nothing is included in them that is not necessary in fact or in good engineering practice; that they are neither padded out nor skimmed, in a word; that *they are a fair and honest picture of what would really happen.*

This is the engineer's particular domain, and the views of the experienced and practical engineering expert should here receive weight, especially when he shows maturity, experience and fairness in his testimony. The engineer is in effect a court all by himself on this subject, but his decisions must have a reason back of them and must be subject to review.

2. When reproduction, less depreciation, estimates have been fully completed, so that enough cost has been allowed to reproduce the entire property, including the reproduction of the business, then it is the function of the court, aided by the evidence, to reason out the question: "*Is reproduction less depreciation in this case a proper measure of value or a fair measure of value, and if not, why not, and to what extent not?*"

It is here that the Appellate Court has misconceived its problem. It has taken under consideration one of the items belonging strictly to the reproduction estimate and endeavored to reason out of existence an engineering fact that cannot honestly be eliminated, and then with this item alone in mind, the court has endeavored to determine whether it is or is not *value* as applied to the property as a whole.

What the court should have done was first to reason out whether this item was properly a part of the reproduction estimate, and secondly, was it fairly and properly estimated, and thirdly, it should have asked itself: "*Is the reproduction estimate itself, as a whole, a fair and proper measure of value in this particular case?*"

A method of approach, such as is above described, would have placed the court decision on firm and dignified ground and avoided an unfortunate attempt to controvert a fact in the evidence before it, which is ordinarily indisputable.

THE OPINION

To understand fully the application of these economic suggestions, it will be desirable here to quote all of the portion of the opinion in the case referred to relating to the question of Paving Cost, italics marking sentences that will be particularly discussed.

In determining the cost of reproduction the commission allowed \$12,717 as the cost of restoring the pavement as it existed when the mains and service pipes were laid in the streets. The relator claimed an allowance of at least \$200,000 for the cost of restoring pavements subsequently laid on the theory that that cost would have to be incurred if the mains were to be laid today. *But the new payments in fact added nothing to the property of the relator. Its mains were as serviceable and intrinsically as valuable before as after the new pavements were laid.* The controlling considerations under the preceding point also determine this. The rights of the public are not to be ignored. The question has a double aspect. *What will be fair to the public as well as to the relator?*

(Smyth v. Ames, supra). Should the public pay more for gas simply because improved pavements have been laid at public expense? It is no answer to say that the new expensive pavements suggest improved conditions which, though adding to the value of the plant, will not, by reason of the greater consumption, add to the expense per thousand feet of the gas consumed. The public are entitled to the benefit of the improved conditions, if thereby the relator is enabled to supply gas at a less rate. *The relator is entitled to a fair return on its investment, not on improvements made at public expense.* It is said that the mains will have to be relaid. So will the new pavements, and much oftener. Both might possibly be relaid at the same time. The case is not at all parallel to the so-called unearned increment of land, that the company owns. *It does not own the pavements and the laying of them does not add to its investment or increase the cost to it of producing gas.* The cost of reproduction less accrued depreciation rule seems to be the one generally employed in rate cases. *But it is merely a rule of convenience, and must be applied with reason.* On the one hand it should not be so applied as to deprive the corporation of a fair return at all times on the reasonable, proper, and necessary investment made by it to serve the public, and on the other hand it should not be so applied as to give the corporation a return on improvements made at public expense which in no way increase the cost to it of performing that service.

The Appellate Division felt bound by the decision of the United States Circuit Court in the Consolidated Gas case (157 Fed. Rep. 849), and it is true that such an allowance was made in that case. But the United States Supreme Court held in that case (212 U. S. 19) that the rate established was not confiscatory, and did not pass on the propriety of that allowance. What was said in the opinion on the subject of present value was merely a general statement having no necessary relation to the question now under consideration.

Reviewing the opinion as above quoted, it must be apparent:

1. The reasoning of the court does not seem to show a clear distinction between investment or actual past cost expenditure and the reproduction cost as of today, which latter it is in reality discussing.

2. The court alters engineering facts to fit its reasoning, rather than attempts to fit its reasoning to the engineering facts.

3. The court needlessly increases its dilemma by reasoning about the value of the property as a whole, with only one of the items of reproduction estimate in mind.

THE NATURE AND USE OF REPRODUCTION ESTIMATES

A little thinking on the nature and purpose of "*reproduction cost less depreciation*" as a line of cost evidence, useful in arriving at the value of public utilities, will convince almost anyone not prejudiced in the matter that if this kind of cost evidence is worth anything at all as an aid to valuation, it is because it produces something concrete and tangible; something which can be checked by experience and common sense; something which is so commonly done and so often repeated that engineers at least know fairly well what would happen under a given set of conditions.

A competent engineer, with the proper experience, can tell what it would cost today to reproduce a property, because he is, and has been for many years, reproducing properties. It seems an entirely practicable proposition to him at least, if not to the layman or the court. Once the engineer is directed to estimate a reproduction, he embarks upon a programme, to him not susceptible of violent expansion or curtailment; his reason and experience insist upon the inclusion of every item that must reasonably be encountered each step of the way.

When a court in its opinion deliberately advises the engineer, therefore, that reproduction is "merely a rule of convenience," apparently it says to him: "We, at least, are not bound down to reproduce this property in a way that is humanly possible if the final costs incurred do not seem to our lay minds reasonable." You must not, for instance, buy land that is now held at very much higher prices than formerly, nor must you compute the excessive cost of laying pipe in congested streets if once, long ago, perhaps, you could have operated in grass grown and deserted thoroughfares only just opened up from adjacent farm lands. Continuing this

logic, it says in effect you must seriously consider the laying down of pipe in paved streets without cutting through the pavements or replacing them, because it does not seem to us that the public should pay rates on this kind of expense.

Certainly engineers cannot acquiesce in any such loose ideas of "Reproduction," as an engineering estimating process.

WHAT IS REPRODUCTION

To the engineer, the reproduction of a property as of today can mean one thing and one thing only, and that is the entire elimination of all methods which are not humanly possible. We are not living in the days of an "Aladdin's lamp," we have no magic wand, nor will we be listened to with respect by the courts if we attempt to formulate a fairy story.

To reproduce a property from an engineering point of view is to proceed in a manner which engineers commonly use to overcome the obvious obstacles that all new construction encounters. It must be done under conditions as they exist today, or will exist in the near future, during a reasonably rapid period of construction. The life work of the engineer is to estimate in advance what the obstacles to such a process will be, and what it will cost to overcome them, and what will be humanly practicable to accomplish, and to advise the engineer that certain obstacles to a reproduction which he can clearly see must exist, should not be estimated because the result will be too high or too low, is as great a fallacy as to direct him in his estimates to use three as the product of two times two.

To compute the cost of only a part of a structure and call it "reproduction" is worse than a misnomer, for if the facts on which valuation reasoning are based are incorrect, the valuation reasoning itself is vitiated.

Some courts and commissions confuse themselves at times by calling this item "the value of pavements over mains." This is not a correct designation. The engineer in figuring the cost of reproducing a plant does not compute the value of pavements over mains at all. He computes the cost of the excavation work of cutting through pavements as an obstacle, laying his pipe thereunder, and the cost of the work of replacing the pavement in as good condition as it was before, and this is a very different thing from valuing a pavement, for it has no connection with the cost or "value of a pavement, itself."

HOW "REPRODUCTION" WORKS OUT

Now, it is quite idle to argue that a present day plant can be reproduced without ordinarily incurring such an item as we are here discussing, and the court, fortunately, has not attempted such an argument.

Where then, arises its difficulty?

Obviously because it has lost sight of the true nature, limitations and use of that line of cost evidence known as "reproduction cost," and is dwelling on past cost or investment, which is entirely a different thing.

Let us inquire first how reproduction as of today should be worked as a practical matter.

Reproduction should present a faithful and practical picture of what the city or utility company would face, if they had to build a new plant now, but like the existing plant in all respects. Reproduction less depreciation, therefore, shears away and casts aside from the original investment the following losses:

Losses to the Utility, Gains to the Public

(1) Obsolete structures which although they have served their day are now useless.

(2) Expenditures and investments which though perhaps they seemed wise at the time they were made have since proved to be mistaken.

(3) The higher prices for materials and machines which may have prevailed in the past.

(4) Investments made for population which may not have developed, or developed in other directions than were expected.

(5) Cost of appliances rendered valueless by reason of improvements in the arts.

(6) The wear and tear of the plant.

(7) Changes in public demand, producing obsolescence.

(8) Inadequacy of original plant due to rapidly increasing population.

(9) All other depreciations and losses from whatever cause they may have occurred.

THE OTHER SIDE OF THE STORY

Now, it must be argued in all fairness and justice, that if we are to thus wipe out, by the reproduction of the plant as of today, all this kind of past investment which may have been made honestly and in good faith, every consideration of fairness and justice requires us to face the fact that utility properties when considered as being now recreated, must take fully into account all the obstacles which they did not originally have to confront. Among these obstacles may be mentioned:

Gains to the Utility, Losses to the Public

- (1) Increased cost of land.
- (2) Increased prices for labor and certain materials and often the high cost of living.
- (3) Difficulties connected with installing a plant amid a more dense and exacting population.
- (4) The necessity of conforming to police regulations and city ordinances made necessary by increased traffic and the public convenience.
- (5) The necessity in underground distribution systems of meeting and avoiding an increased number of other utility conduits, such as sewers, gas or water, telephone or telegraph conduits, service pipes, heating mains, and the numerous pipes which in a more developed city, crowd the subsurface area.
- (6) *The necessity of cutting through and replacing pavements.*
- (7) The necessity of passing under steam railroad tracks, street car tracks, bridges, viaducts, and other improvements not now possible to avoid, but perhaps nonexistent at the time of original construction.

Clearly, if we must, by the force of correctly reasoned and carried out reproduction, eliminate all the obsolete expenditures, the mistakes of the past, the depreciation which property has suffered, we must, as well, find the cost of reproducing the property under the present conditions, with full allowance for such obstacles as the present conditions impose upon us. In reproduction we cannot be just, and neglect, on the one hand, the things which favor the property, and, on the other hand, include those things which are unfavorable to the property. If we are going to dispense with the obstacles which a present day reproduction must meet by some

process of "rubbing an Aladdin's lamp," then, to be fair and just we must also include in our cost estimates the past obsolescence, that is, expenditures for structures which have disappeared, and immediately we do this *we are not reproducing the property at all but are investigating its past history from the investment point of view.*

REPRODUCTION IS A SEPARATION FROM THE PAST

The reproduction method has nothing whatever to do with the past. It is true that recent past experience is our guide in deciding what proper costs are to be used in a reproduction, but such recent past costs are considered only as they aid the judgment in arriving at what the present and near future cost conditions will be. Reproduction, if it means anything at all, means that the engineer is to estimate the cost of a theoretical new work, just as he estimates the cost of any actual new work he may be charged with. To mix actual past costs into reproduction costs, without a review as to whether they are similar to present costs, is a fatal state of mind, and opens the door, especially with the layman, to all kinds of confusion and unreason. Past cost data is only data, and as data it is only of value as it helps us to determine what the present or near future cost would be if the property had to be built new beginning today. The nearer to the present, therefore, that we have data on past cost, the more useful such data usually is in helping us to formulate the future cost of reproduction estimating.

Reproduction a Complete Entity

Reproduction when complete is an entity, a complete whole. Unless it is complete it is dangerously deceptive as a line of evidence. To estimate what it would cost in part to rebuild a property, and then stop and try to reason from that incomplete reproduction the full value of such a property is to start from a false base. Such partial estimates are especially dangerous when the courts or the appraiser does not observe that they are not complete. If one estimates the cost to rebuild a house up to the top of the first story, how will that very much help him to find the value of the two story house he is reproducing and wishes to value? He must reproduce the cost to complete the whole house and then reason whether the house is worth that much or not.

The besetting sin of valuers new to the art is to estimate re-

production partway through, and then stop and try to reason about value of the whole property. They do this often because they think of reproduction as a final summing up and they get afraid they will be led to some conclusion by the reproduction formula to which they do not want to come, so they stop in the middle of things and wrestle with value of the property as a whole when they have no business to be thinking of anything but the reasonableness of the reproduction items.

There can be no formula for reasoning out value.

Some of the mental difficulties which the court encountered in trying to reason value for the property as a whole from partial reproduction items can be well observed in the following quotation: "But the new pavements, in fact, added nothing to the property of the relator."

Is this or is this not true?

Some simple questions can be asked which will apparently throw light upon the question.

If a city desired to build its own municipal gas plant in this instance, would the fact that the utility company's pipes were already under the pavements give them any special value in its eyes?

Would a utility distribution system be likely to have as much value for sale or as a basis for an issue of bonds in an unpaved city as a paved city?

Do pavements over mains facilitate the installation of competitive conditions, or do they deter them?

If a city which never had a gas or water plant but which was well paved should decide to install one, would it cost more or would it cost less because the streets were paved?

If a city had a new gas or water plant installed and great expense was incurred in cutting through and replacing pavements, should the public properly pay rates on this expense or should they escape making a fair return on this portion of the cost thereafter?

An honest answer to these questions would appear to destroy the conclusion of the court on this question.

FAIRNESS TO THE PUBLIC

The writer has been asked several times on the witness stand by commissions or counsel: "Do you think it is right that the public should pay return on the value of paving over mains?" and he is

accustomed to reply, "Yes, if reproduction is found to be a proper measure of the present value of the property, and no, if reproduction is not such a measure."

This kind of an answer is necessary because the question presupposes that reproduction less depreciation is a final formula for the value of the property as a whole. It is in reality only one of the facts helpful to a determination of such value.

Continuing our analysis, we find the court further says: "The rights of the public are not to be ignored. The question has a double aspect. What will be fair to the public as well as to the relator?"

Setting aside an objection to this sentence that there is no time in valuation matters when one should forget the double aspect of the question and what will be fair to the public as well as to the utility, let us inquire how the allowance for paving, so called, is unfair to the public. It is granted in reproduction estimate that the public ordinarily paid for the paving and it is conceded that the company ordinarily does not own it.

The key to this doubt about fairness lies entirely in the misconception of what the item is estimated for, and how it is to be used, as has been shown. It is not for the "value of the pavements" at all, but it is part of the natural cost of reduplicating the property under present conditions, and it has been shown that in a logical reproduction as of today, this increased difficulty to pipe laying cannot be avoided.

If, then, there is any unfairness about this item at all to anybody, *it is because the entire reproduction less depreciation method of fixing value is unfair*, and not because any one necessary item of it is unfair.

Now the question as to whether the entire reproduction method is a fair or unfair method to apply in any given case is an entirely proper one to raise; in fact, no valuation is properly made and completed unless this question of the fairness of the whole reproduction method to any particular case is thoroughly investigated.

WHEN REPRODUCTION IS UNFAIR TO USE

It very frequently happens that reproduction less depreciation is entirely unfair to one side or the other. It is at times unfair to the public in the following instances:

1. When a utility company has installed in construction far greater,

more costly or more numerous structures than it needed reasonably to have installed.

2. When the population and demand have diminished in the course of years so that there is no longer any need for so large a works.

3. When the existing works do not adequately meet the changed conditions of the public need but still are efficient for the purpose for which they were originally designed.

4. When the builders were guilty of extravagance, wastefulness, or misjudgment, dishonesty or graft, resulting in too unreasonably expensive structures or machines.

5. When the prices for labor and material at the time the reproduction estimate is being made are all abnormally high, due to boom periods or acute market scarcity of materials.

Other situations in which reproduction less depreciation are unfair to the public might be added to this list.

Again, it is unfair to the utility company:

1. Where it owns and controls valuable processes not generally available, or, say, the sole source of supply, as, for instance, in water supplies from a limited number of desirable springs, or a peculiarly favorable geological or physical opportunity not readily duplicated.

2. Where skillful designers and experienced builders have accurately forecasted the changing needs of the public or of the future and economically provided properly for it with wisdom, skill, and good judgment.

3. Where conditions of great hazard and risk have arisen and have been successfully overcome by ingenious and skillful engineering design costing but little to introduce.

4. Where careful study and prudent investigation have produced an engineering work that results in special savings in operation not ordinarily available.

5. Where the prices for labor and material at the time the reproduction estimate is being made are largely depressed due to panics or periods of temporary depression.

WHEN IS REPRODUCTION A FAIR MEASURE OF VALUE

In valuation work, it may be said to be a fundamental principle that the cost of reproduction as of today in a manner that is humanly possible and practicable to the engineer, less the depreciation of the property *must be the least value which can be put upon the property when the following conditions obtain:*

1. That the utility's product is needed by the public.
2. That the service is satisfactory.
3. That the city is prosperous and growing.
4. That no serious mistakes of engineering or finance have developed in the past history of the plant.
5. That the cost of the service to the consumer is less than any substitute service.

Under the above conditions, it is obvious that if the public utility property, whether owned by the city or the company, were suddenly wiped out of existence, its value to the community would be the cost of restoring it under existing conditions, i.e., in the near future, including the losses in revenue sustained while so doing, and, of course, all in a manner humanly possible as an engineering problem. When so estimated and restored, its cost would be the least possible value that could be put upon the property. The greatest value which the property could then have would be the cost to the consumers of installing a supply in the next most available way, in other words the worth of the service to the consumer demonstrated.

SHALL WE RETRACE AN INVESTMENT OR VALUE A PROPERTY

It is to be regretted that the Appellate Court, after making so clear an argument for the inclusion of going value, and after showing in that argument that it considers that reproduction was the up-building of a new similar property as of today, should so reverse its reasoning when taking up the matter of pavement costs, for in the latter argument its mind was clearly on the past cost and history of the property rather than on the reproduction which it is discussing.

Three times in the opinion quoted it uses the term "investment," while only once near the beginning does it use the word "property." "The relator is entitled to a fair return on the investment."

And again: "It does not own the pavements, and the laying of them does not add to its *investment* or increase the cost to it of producing gas."

"It, reproduction, should not be so applied as so to deprive the corporation of a fair return at all times on the reasonable, proper and necessary *investment* made on it to serve the public."

Now the term "investment," as has been shown, is used to describe the cash which is usually put into an undertaking or has been put into such an undertaking in the past, and we have already quoted Webster's definition.

It is obvious that the term investment is not synonymous with value. An investment in a property may produce a value as time goes by much greater than the actual money expended or it may become a total loss.

The term "investment," therefore, as applied to a utility being valued, must necessarily relate to the money actually expended in the past to build up the property.

Now it is quite evident not only from the use of the term "investment" but by the entire method of expression and argument, that the court in writing its opinion was thinking of the actual money that had been expended in the past. But the subject under discussion is reproduction in the present, an entirely different thing.

If the court had decided on reviewing this case that investment or actual past cost was the best way to measure value of the property as a whole in this particular instance, then it is under no necessity to discuss reproduction at all, because reproduction has no bearing at all on past cost or investment, and if the court wished to use the basis of its past investment as a measure with which to value the property, then it can properly reject the item of paving if it were presented to it, because the cost of cutting through and replacing paving does not enter into past or investment cost unless the pavement actually existed at the time the pipes were originally laid.

But the court in this case is actually reviewing evidence presented to the commission to show reproduction estimates as of today, and in reviewing this evidence comes upon the stubborn fact that a reproduction as of today must include overcoming certain obstructions which did not originally exist, and it proceeds to utilize arguments against these obstructions proper enough in discussing past cost, but entirely improper in discussing present reproduction cost.

This is creating an entirely useless and needless dilemma, because of the lack of clear distinction between past or investment cost and reproduction cost.

DO PAVEMENTS INCREASE THE COST OF GAS

Incidentally it may well be pointed out that the pavement over mains, as an engineering fact, do increase the cost of delivering gas, if not producing it. In the city of Chicago alone, maintenance, and operating repair work is seriously increased, because the equiv-

alent of from six to eight miles of full width pavement are necessarily torn up and replaced every year in the ordinary course of repair and maintenance work to the gas pipe system, and it is indeed hard to see how this necessary expenditure does not increase the cost at least of delivering gas.

Much more might be said here upon the legal status of past cost and reproduction cost as two distinct lines of inquiry from which to reason value, but such line of thought is not entirely proper in this review, which seeks to confine the question to its economic and engineering aspects.

IN CONCLUSION

In making this analysis of the opinion of the Appellate Court in this case, the writer is very far from taking a critical attitude for the mere sake of being a critic, or of controverting the opinion of an honored court. The writer has the utmost respect for the duties, responsibilities and difficulties under which the courts labor, and is firm in the belief that the courts have in the main enunciated a body of sound reasoning which is going far to solve the difficult questions which are raised in valuation matters.

It is, therefore, only with the hope of being helpful and of placing judicial decisions in engineering or semi-engineering fields on a sound basis of reason that he has undertaken the present unpleasant task.

The Appellate Court is by no means the only responsible body that has had difficulties with this perplexing item. Most of the commissions and engineering experts have been much troubled over the matter in the absence of fundamental guiding principles, and the writer is free to confess that for a short period in his early attempts to solve the "pavement cost" question, he, too, partially adopted the conception to which the Appellate Court has seemed to come. It was only by thinking out fundamental methods, applicable alike to all conditions, that the conclusions herein set forth were reached. and the opportunity of again presenting them to those charged with appraisal duties is here undertaken in this specific instance only in the hope that further light will be thrown upon a difficult matter.

DISCUSSION

MR. FRANCIS H. LUCE: Mr. Alvord has accomplished something that is interesting to a good many, by emphasizing the fact that figuring reproduction new is only a means to an end. It would seem that our engineers are responsible in a large measure, through the fact of their dealing so strongly with this reproduction value new, in confusing the minds of people as between the two things, reproduction value, and actual value. We all know that they have not a very close relation. Our experience in building a plant, for instance, is that much of the extension work is done during periods when the material is high and labor is high, and the cost amounts up. In a plant the speaker has in mind most of the material that has been used has been put in during periods when prices of pipe have, probably, ranged from \$33 to \$40 a ton. An engineer who attempts to figure the value of that plant by figuring reproduction value probably would not arrive at much nearer than one-half of the value of the plant today, not the investment, but the actual value. The investment might have been double or more than double what the reproduction new would be, but the actual value today is double what the reproduction value would be, because its earning capacity is there.

Mr. Alvord has done a valuable thing in emphasizing the fact that we are playing on this one string too much, that is, the reproduction value new, and thereby confusing the mind of the Court with the idea that this has a great effect upon the total value, whereas, as Mr. Alvord has said, it is simply a guide in figuring, as a means to an end.

MR. F. W. CAPPELEN: Mr. Alvord is absolutely correct in his contention that the cost of paving must be included in the cost of reproduction. The question has frequently come to the speaker's notice. Assume that a gas company has a 6-inch main laid on several blocks when there was no pavement. Later on the gas company finds that it is absolutely necessary in order to do business to have a 16-inch main on those various blocks. When the 16-inch main is put in, the street is paved with asphalt or some other kind of pavement; the gas company must go to the city and ask permission to relay that main; take up the pavement and open the street. Then the city afterwards replaces the pavement and charges the com-

plete cost of such replacement to the gas company. There have been a great many cases of that nature in Minneapolis, where the average cost of replacing pavement is about \$2.50 per square yard. That is charged to the gas company, of course, and is a fair charge, and the gas company must put it against its operating expense. Now, considering a new proposition altogether, you are reproducing a 16-inch main, you are not reproducing a 6-inch main; you are reproducing also a new pavement, and you have to provide for it. It seems peculiar that the courts can look at it in any other way than the one that Mr. Alvord has suggested.

MR. H. C. HODGKINS: The paper covers a great deal of ground, but the thought which seems most prominent is that the author has assumed to criticise the decision of the court. Many of our legal friends would doubtless call that effrontery; yet there is no good reason why the engineering profession should not point out the right way as well as the legal profession, except that the legal profession through the courts has the last say.

The idea used to prevail that a lawyer was supposed to be thoroughly versed in architecture, engineering, science, medicine, and theology, in fact, was supposed to know everything. They have come to know that there are some things which they have to learn of the other professions; for instance, the paving question came to the speaker's knowledge, in Chicago, in connection with the telephone company. They were required to have their wires underground, and whenever a street was opened and a new pavement laid, they took the opportunity of getting their conduits into the ground, although they would perhaps have no use for them for the next 5 or 10 years. Could any one undertake to say because they took advantage of that opportunity, that thereby the conduits were not worth more money when they came to be used than though they had not taken advantage of that opportunity?

Clearly it appears that the pavement over that conduit added to its value to the extent of what it would have cost if they had delayed putting it in until they had to cut through the pavement.

The profession has been criticised somewhat for just such expressions as are in this paper. However, we have learned that the courts do sometimes reverse their decisions, and that a correct conception of engineering questions is not always obtained and does not always appear from the decisions. Therefore, the author of this paper is

quite justified in maintaining that the right line of reasoning was not applied in that judgment. Although the judgment of the Court of Appeals will be quite generally accepted, yet it is quite possible that a better conception of the question would bring about a better result, and perhaps greater justice to utility corporations and the valuations which they ought to receive.

MR. R. B. HOWELL: Will Mr. Alvord please state what was the proper method of arriving at the sum of \$200,000 for this pavement? Was it so much per square yard, or so much per foot of pipe?

MR. JOHN W. ALVORD: The author is not familiar with the detailed figures in that case; it was a gas case (Kings County Gas and Electric Company), but assumes that that was the cost of cutting through the pavement and replacing it, not reproduction value. That question was not submitted to the court.

MR. R. B. HOWELL: It seems that reproduction value based upon that premise would not be correct, unless there was taken into account the period of time for which that main would probably remain under the pavement. For instance, if the life of the pipe was exhausted with the exception of say 3 years, you can say that the cost of repaving figured in that manner would be unjust to the municipality, because in a period of 3 years the pavement might have had to be cut and relaid, and a new main laid, or there might be a case where the main was inadequate. As the speaker understands it, in nearly all the cases where the cost of repaving is added, this fact has not been taken into consideration; and it must have been such considerations as these that led the court to the view which it took; in any other case the question is theoretical. In any other case you have to take into consideration all the facts, and whereas justice and law are not synonymous, the law not being any more exact than any other science, they have probably realized that here was a dispute that should be settled with justice, and the court took this view; and upon that theory alone you can sustain the position of the court. The fact that there is a belief that has spread throughout the country that engineers are somewhat responsible for the payment by municipalities of excessive prices for public utilities which they have purchased lays upon the engineering profession a duty to see to it that those doubts are not all resolved in favor of public utilities corporations.

MR. C. B. SALMON: The question considered by the court in the Kings County case did not refer in any way to the age or the condition of the pipe under the paving or the pavement itself; as that was taken care of in the valuation and depreciated to its present worth. The paving would certainly take no longer life, and in all probability was depreciated on the basis of its own life—in which case when worn out it would have to be replaced by the city and not by the water or gas company.

In the lower New York Court of Appeals case all paving over mains whether placed before or after pipe laying was allowed, as well as present value of land and "Going Value." In the appeal to the higher State Court the cost of laying pipe under pavement was not allowed unless the pipe was laid after the pavement. The cost of paving over mains was not considered unless the mains were laid after the paving was placed. The present value of land and "going value" were sustained.

Now the question referred to by a speaker, that in the course of a few years, four or five, another pipe might have to be laid, would not enter into this decision, for the reason the pipe and pavement have already been depreciated to present value, and the company would have to replace their pipe if worn out, the same as they would replace a piston in a pump, or a flue in a boiler when worn out; and that would come under operation or out of surplus account and they would not be allowed to make additional value for returns.

If you go farther in the line the gentleman has spoken of, it would bring out a great question; but it is a fact, which engineers will not attempt to dispute, that because until lately depreciation was not charged off, there were no water works constructed in the earlier periods, except in very special instances, like perhaps Los Angeles, in rapidly growing cities, under favorable conditions, where the water works ever made any money. It was not considered that the rate established under a franchise would produce a profit sufficient to take care of all unexpected losses. The experience of the last 30 years has shown that early investors were fooled, because, except in a few special cases, the demand did not increase fast enough or largely enough to take care of the property, to give the investor or the builder, if he still owned his property, a fair return from the inception of his plant to the present date; allowing for depreciation. For that reason the "going value" of the early cost of securing an income equal to the present income is now con-

sidered and allowed by all State and Federal Courts. If the net receipts of the plant have finally become sufficient to pay for those early losses and depreciation to present value and still show a surplus and maintain the property with fair return, then the proper way is to reduce rates but not omit "going value." Some courts hold it obligatory to value "going value" or set aside the valuation entirely. So the question of the rate in the franchises does not by any means assume or prove that it was anticipated that that rate would take care of all the early losses and the unexpected and unknown things that have since occurred in the construction of waterworks and the present demands of the public.

MR. W. A. PATTON: In regard to the pipe in the gas plant that has 3 years yet to live, the difference in the value of new pipe and the pipe that has but 3 years to live is covered in the depreciation. Thereby the city only pays a certain per cent of the original value in taking the plant.

But if the court rules that the theory of reproduction and depreciation shall be the basis for estimating the value, then it is a plain duty to allow the company the benefit of the changed conditions where the value of the pipe line is increased on account of being located under pavement that was built after it was laid.

A house may be built one mile from a city and possess a certain value; 10 years later the city may be built around the house and thereby immensely increase the value of the house. No one would question that the owner of the house is the beneficiary of that increase. In the same manner the owner of a pipe line should be the beneficiary when its being favorably located under the pavement increases its value and the city should pay for that increased value when it takes the plant.

Mr. Alvord in his paper referred to situations where machinery that was obsolete would not be considered. If a company in operation for years past gets no consideration for an investment amounting to large sums for machinery that has outgrown its usefulness, but which was used for building up the business, it would not be proper to say that the company should lose all that and still get nothing for the going value of the business that has been built up. This is a question on which this association ought to go on record; it is a question important to every person that has a dollar invested in a water works plant; it is a question which we know that the courts in some

cases have been wrong in ruling upon; it is a question that we ought not simply to pass over, but this association ought to go on record so that through its action the courts might be enlightened and adopt the conclusions set forth in the paper which Mr. Alvord has read to us, and which should be concurred in as the sense of this association.

MR. R. B. HOWELL: Let us take, for instance, a 6-inch water pipe, say it costs \$1.25 a foot to lay and say that 3 feet or 1 yard costs \$3.75, and the paving \$2 a yard, or a value of \$5.75 for laying the pipe and the paving. Let us suppose that this particular pipe had depreciated so that it was worth 25 cents a foot, that paving would still cost \$2 to relay, and then the municipality would be paying \$3.75 for pipe that was worth 75 cents in the ground, \$3 for the pavement and 75 cents for the pipe. Now is that just to the municipality? It is evident that it has got to take up that pipe shortly and relay it and then it has to replace the paving and pay for it. If the pipe were new, the pipe in the ground might be worth to the municipality \$5.75; but if the pipe only had a short life and was worth but 75 cents, then certainly the municipality ought not to be charged \$2 for the paving as it would have been if the pipe were bought new. It is probably considerations of this character that entered into the judgment of the court, or as somebody has said, courts are instituted for the purpose of starting disputes, and those disputes are not always settled with regard to actual justice.

If we take that view of the courts, and the courts take that view of themselves, then it must be realized that they are going to take into consideration factors of this character and not pass them by, and very properly. The court has to seriously consider whether it would be justice to the public under such circumstances to assess the full value of relaying paving over mains that might have had but a short time left to live.

MR. MORRIS KNOWLES: The speaker feels that the association owes a debt to Mr. Alvord for drawing so clear a line of demarcation between different yard sticks for measuring value; and for calling attention to the necessity when using one method of calculation of going right through with it to the end, and of avoiding confusion by refraining from occasional jumps to some other method.

Estimated cost of reproduction new is only one of several yard

sticks; historical cost, shown by the books of the utility, or as estimated on the basis of original conditions and prices, is another. But, when estimating the cost of reproduction, we should carry it through to its logical conclusion, estimating, as the author has pointed out, the cost of construction at the present time, under present conditions, and at present normal prices. The conclusion is unavoidable, therefore, that in estimating cost of reproduction we must take into consideration the fact that pipes are laid under streets that are paved.

When we have the answer we must then decide how we will regard it, and how we will use it. This is a separate step and a distinct problem by itself, and one on which there may reasonably be a difference of opinion. The speaker would certainly not agree with one of the previous speakers that the lawyers will have the last say in this matter, for within recent years there have been numerous instances in which the courts have advanced beyond their earlier position in accordance with progressive public opinion. Such changes have been particularly well illustrated by decisions relative to social legislation, such as Workmen's Compensation and laws regulating the hours of labor of women and children. It is clear therefore that the courts change as the times change, as you and I and the man on the street become educated and progress to new points of view. There is no valid reason therefore why the decision of a court should be looked upon as the last word and the end of progress. Certainly we have as much right to disagree with some decisions as we have to differ in our opinions with other men, even though we may agree to live for the time being in respectful obedience to the decision whose wisdom we question.

Neither is the speaker ready to admit the contention of the last speaker that because cost of reproduction is often higher than original cost, the engineer making the estimate is attempting to inflate value. The conscientious engineer must pursue his work to the end whatever the conclusion; but it does not necessarily follow that fair value must be based exclusively or even principally upon estimated cost of reproduction. Fair consideration must be given to all other measures of value available; and since there is something of the spirit of partnership in the relation between the public utility and the community which has given it the use of public property and permitted it to share in the right of eminent domain, it is frequently proper that fair value shall be fixed somewhere between

actual investment and reproduction cost, so as to permit both utility and community to share in the increments of value which have resulted from the growth of both.

MR. J. N. CHESTER: The speaker can hardly take Mr. Howell seriously in his building up from \$1.75, or \$3.75 and then adding to that \$2 for the cost of paving, for, if he depreciates the paving along with the pipe, as he should do, he will reach a fair conclusion.

MR. EDWARD WEGMANN: Two or three years ago the speaker had to make a valuation of the property of two large private water companies, to determine the rate charged; and in those cases, working under the orders of corporation counsel of the city of New York, the court ruled that the companies were entitled to the cost of the paving which had been there when they laid the pipe. A great many million dollars has been paid for those pipes over and above the original cost. The instructions were to allow the paving in every case, and the cost of taking the pavement up and putting it back. Has that been reversed by the decision mentioned in the paper? That was the decision of the Court of Appeals of the state of New York in the Consolidated Gas Company case, which was a famous case.

MR. JOHN W. ALVORD: That case, as it is recalled, approved of the inclusion of the cost of cutting the pavement. The Consolidated Gas Company case went up to the Supreme Court on the question of the inclusion of the cost of cutting the pavement, and it was held that it was to be included in the estimate of cost all the way through.

MR. C. B. SALMON: Perhaps there is a little misunderstanding here as between the United States Supreme Court decision in the Consolidated Gas case and the Kings County case before the Appellate Court of New York. The Consolidated Gas case was previous to the Appellate Court case. In the Consolidated Gas case the court's controversy was very largely upon the value of the land, the company contending that it was some \$5,000,000 or \$6,000,000 more than the city valuation; and the case was carried up largely on the value of the land; and the United States Court decided in favor of the present and the company's value; whereas the value of the pavement over mains was not made much of and at that time

was a small item as compared with the value of the land. In deciding the case, the court did not refer to the pavement but allowed it in the gross valuation and decided the case upon the present value of the land as decided by the lower courts, including what cost there was valued in the pavements; but in the King's County case, the value of the paving put in after the pipes had been laid was refused; so that while the Supreme Court of the United States allowed in the Consolidated Gas case the amount of the paving which the company claimed; the decision itself did not go into any details, except to include "going value" and present worth of real estate. That case, is the case, gentlemen, you may wish to refer to, as some of our commissions are trying to take up the original cost of the land as the only value to be allowed in the valuation of a utility property; but you have only to refer to the United States courts which invariably have decided that in estimating the value of the land, it is the present value of the land, that is to be taken into consideration, not the original cost.

If the reconstruction of a utility, depreciated to the present value, is the proper method of valuing such a property, then Mr. Alvord's criticism is both eminently proper and respectful. That it is a proper method of valuation the Federal courts have repeatedly decided. Reconstruction carried to the logical end certainly must rebuild the present works as they now exist. If there is pavement over the pipes it must be torn up and replaced, and the cost of doing this would have to be considered in rebuilding the present plant by reconstructing a new like plant.

It is claimed by cities that the company should not be allowed this increased value, because the city added it, by putting the pavements over the mains without any cost to the utility; but the United States courts have decided that a utility is entitled to any enhanced value that may have come to the property "whether caused by the growth of the city or otherwise."

The growth of a city necessarily demands pavements for the convenience of the public. Water mains are usually ordered by the city in advance of pavements because water is a necessity, and pavements follow by growth of the community as a convenience: often water mains so ordered do not pay the community for a long time. After pavements are put down, values increase; because larger and better houses are built requiring more water, and increasing the water receipts, thus making a water main under a paved street more

valuable than on an unpaved street. In addition to the reconstruction theory, the water or gas mains actually become more valuable by this enhancement, created by paving, in the same way that land values increase on a paved street. For this reason state and federal courts allow present value, instead of original cost, on land, buildings, machinery, and pipes, whether higher or lower than original cost. A proper valuation of a utility should be made by men experienced in that line. Judges may or may not have had that experience; therefore, with all due respect, values might properly be left more largely to the judgment of the engineer.

MR. J. W. LEDOUX (by letter): The term "cost of reproduction" is in the writer's opinion rather unfortunate. It should be the "estimated cost of reproduction." We generally conceive of a cost as something definite, and therefore calculations of valuation made by engineers or others should have their proper designation. They cannot be anything but estimates unless they are taken from the actual records of the case under consideration.

There is only one element of valuation that is infallible and unchangeable, and that is the "past cost." As soon as we depart from that procedure in determining valuation we obtain figures that will vary according to the purpose for which the valuation is to be made; but, nevertheless, this is the plan adopted by the courts and in consequence, by engineers. It is generally assumed or found that the past cost cannot be obtained with certainty, because the books have not been properly kept, or the records have been lost, or the results show something so abnormal as to be unacceptable to the courts or the valuers; therefore, it becomes necessary to use some other method of arriving at the valuation, and it will vary according to the circumstances:

(1) If the water company has a franchise based on exclusive rights in the territory and fixed rates, and the municipality has no right of purchase by condemnation, valuation would be logically based on some capitalization of the net revenue.

(2) If the water company does not have exclusive rights and the municipality has the right at any time to purchase by condemnation, the valuation would be based on the estimated cost of reproduction of the physical plant and the business.

(3) If a municipality or state has the right to change the rates of a water company and the valuation is to be made for this pur-

pose, then it would seem that the most logical method would be to determine what has been the investment of the water company to bring the water works to its condition at the time of the valuation. If the figures of actual expenditures are unavailable, or if they are such that the valuator considers them abnormally high or low, according to reasonable average practice, it should be his duty to make the proper adjustments but to keep in mind at all times the conditions under which the plant has been developed, on the assumption that the water company is entitled to a fair return on the investment from the beginning. Logically in this case, the valuation of the works would be lowered if the water company had been earning too much and raised if it had been earning too little. The personnel of ownership, the sales or purchase of stock or bonds should have nothing to do with this method of obtaining the valuation, and on the same line of reasoning, depreciation would be ignored as well as the subsequent laying of pavements over the pipes except in so far as they affect the operating expenses and the cost of always maintaining the works in a 100 per cent condition.

If a capable, experienced and fair minded valuator be given a case to determine what is exactly fair between the two parties he would have to take the circumstances of the particular proposition, and this would certainly be the ideal method of obtaining valuation, but the common practice is for each party to have an array of partisan witnesses who naturally present all the points to aid its own particular side, and the court must arrive at what is fair from all this conflicting testimony.

MECHANICAL ANALYSES OF SANDS¹

BY PHILIP BURGESS

To the sanitary and hydraulic engineer the period of 1890 to 1895 is of great importance, because it marks the beginning of the present very remarkable growth of water purification plants especially in the United States. English, or slow sand, filters are adapted to the purification of the comparatively clear waters of the Eastern States, where this work received its first important impulse, so that much of the original investigation work along the lines of water purification was directed to the study of filters of this type. The Massachusetts State Board of Health stands conspicuously in the position of pioneer in this work, and its reports, especially for the years 1890-1892, mark a distinct period in the growth of the art of water purification.

Early investigations of this Board and of other workers indicated that the efficiency of a sand filter depends very much upon the size, or range of sizes, of the sand grains composing the filtering material. Consequently, it was necessary to devise some efficient method of analyzing the filter sands for comparative purposes, and the method described by Mr. Allen Hazen in the report of the Massachusetts Board for the year 1892 was developed to meet the requirements which existed at that time. This method proved so satisfactory that it has been generally adopted by the sanitary engineering and chemical professions up to the present time.

Within recent years, however, the engineering field requiring accurate analyses of sands and gravels has broadened very greatly. A comparatively new type of filter, called the American or "Rapid Sand Filter," has been developed and has been found to meet the average requirements in the United States, outside of the Eastern

¹ During the discussion on this paper a motion was made by Mr. Paul Hansen, seconded by Mr. J. M. Diven, that a committee to consider revision of methods of sand analysis be appointed; the motion was, after some discussion, and the suggestion of several names for members of the committee, put and carried.

states, more efficiently than does the English, or "Slow Sand" filter. Experience indicates that the size of the sand required for a rapid sand filter differs materially from that generally used in the construction of a slow sand filter. While the methods of analysis employed for sand used in the slow sand filter may readily be adapted to the analysis of sand required in the rapid sand filter, the usual method of expressing results in terms of effective size is not entirely satisfactory, because the range of sizes of sand permitted in rapid sand filters frequently is very much less than is commonly used in the filtering material of slow sand filters.

Moreover, recent engineering literature contains many references to a still further and, perhaps, more important use for mechanical analysis of sands and gravels, namely, in the selection of materials required for concrete mixtures. It is now recognized that arbitrary standards or proportions for mixing the aggregates required to form water-proof or dense concrete are no longer satisfactory, or to be recommended, because of local differences especially in the size and ranges of sizes of grains or particles composing the large and small aggregates.

A still further use of mechanical analyses of sands is in the preparation of asphalt mixtures such as are required for certain types of street pavements.

In view of the very rapidly increasing use of, and necessity for, accurate analyses of sands, it is remarkable that recent engineering literature contains so little matter describing or discussing the proper methods of making such analyses. On account of the lack of such standard methods, it is not surprising to note that specifications covering the use of such materials frequently are extremely weak and ambiguous. Such weaknesses, of course, tend to increase the cost of work and frequently result in a very unsatisfactory quality of material.

Another feature of the situation, to which the present lack of standard methods of analysis contributes, is the fact that the manufacturers of apparatus required to separate materials into specified sizes, or range of sizes, find it extremely difficult to satisfy the specifications and requirements of engineers in this respect. This is particularly true in regard to the preparation of sands required for filtering material. It is seldom that a local community does not have available, within reasonable distances, satisfactory material as required for the preparation of a filter sand, but, on account of

lack of knowledge on the part of the local contractors, or of the engineers in charge of a particular piece of work, such local sands are seldom used and filter sand is nearly always imported, perhaps from considerable distances and at large expense.

In view of the increasing importance in the matter it is believed that the attention of the engineering profession may at this time very well be directed to the development and adoption of standards of apparatus and procedure required for the mechanical analyses of sands and also to securing a uniformity of terms required for specifications of materials.

It is believed that some of the confusion which has resulted in the matter has been from the adoption of such terms as "Effective Size" and "Uniformity Coefficient" which are applied to sands used for filtering material. These terms, of course, have little or no significance to an ordinary contractor or to the manufacturer who is in the business of screening and sizing sands and gravels.

Moreover, a further confusion has arisen from the endeavor to use the actual sizes of the sand grains rather than the sizes of the openings in the screens. It was early recognized and appreciated that there may be considerable variations in a sieve used for testing purposes in respect to the diameters of the wires and the spacings of the mesh. Consequently it was considered that the nominal spacings of the meshes per inch were of no consequence in determining the separation of a sieve. This view of the matter, of course, required a determination of the relation between the average diameter of the openings and the size of separation of a sieve, or more properly the determination of the actual size of separation of a sieve. Because but few engineers have available the equipment required to standardize sieves, in many instances the results of analyses have been reported in terms of numbers of meshes, or wires, per inch. This method of expressing results, of course, is indefinite and inaccurate, because wire cloth used in the manufacture of sieves frequently varies both as regards sizes of wires and the number of meshes per inch. Within recent years, this difficulty has been appreciated by manufacturers who in some instances have endeavored to clear up the matter by producing standard testing sieves made in accordance with recent standard specifications and with certain arbitrary intervals of spacings between the individual units. By such means, it is hoped to fix definitely the diameter of the openings in testing sieves. Recently, the Bureau of Standards of the

Department of Labor and Commerce at Washington has adopted standard specifications covering the manufacture of certain testing sieves; also, when solicited, this department stands ready to rate and standardize testing sieves at a nominal cost with a view of determining the actual average diameters of the openings.

The writer believes that the engineering profession should adopt a standard method and standard apparatus for making mechanical analyses of sands and gravels. It is believed also that simplicity and accuracy in reporting the results would be obtained by revising the methods commonly used at present to report such analyses. Possibly that feature which would tend most to clear up the situation would be to change the standard of measurement from the size of the sand grains to the size of opening in a sieve. In view of the fact that testing sieves can now be obtained which are composed of wires of uniform sizes and of accurate spacings, in both directions, it follows that such sieves will, within reasonable accuracy, contain openings of a certain definite size. Testing sieves which do not come within such requirements as are contained in the specifications of the Bureau of Standards should be rejected.

One of the difficulties to be encountered in such a change of standard would be to compare previous analyses with present or future requirements and conditions. Some years ago, while at Philadelphia, the writer made a great many tests to determine the sizes of separation of two nests of sieves; also to determine the relation between such sizes of separations and the diameters of openings in the screens. The average ratio of size of separation to size of opening was found to be 1.10 and was a constant within the limits of accuracy which can commonly be secured in making a mechanical analysis of sand.

Some of the finer sieves examined contained twilled cloth and not directly woven cloth. The average ratio of the size of separation of the twilled cloth to the average diameter of the openings was found to be 1.18. This comparatively large ratio of separation to diameter of opening in such sieves has been stated to be one reason why there is no constant relation between the diameter of opening and the separation of a sieve. As a matter of fact, however, no difficulty need be encountered in obtaining directly woven wire cloth even for the fine sieves, so that a nest of sieves may readily be obtained with a practically constant ratio of sizes of openings to sizes of separations throughout.

In determining the relation between the separations and openings in the sieves at Philadelphia, there were counted over one quarter million sand grains and the work extended over a period of two months. The sieves were rated and rerated until the curves of analyses obtained by examinations of the same sample of material by the two sets of sieves coincided throughout their entire length. Great care was taken, also, to secure accurate measurements of the diameters of the wires and of the number of meshes per inch in both directions, from several parts of the area of the cloth.

In the following table are shown ratings of different nests of sieves with which the speaker has from time to time been familiar:

Sizes of Separation of Representative Testing Sieves for Sand Analysis.

MESHES PER INCH	SIZES OF SEPARATIONS IN MILLIMETERS					
	A-1	A-2	B	C	D	E
4				5.6		5.7
10	2.00	2.00	2.19	2.15		2.09
14				1.45	1.45	
18	1.04	1.05	1.07			
24	0.79	0.81	0.81		0.86	0.78
30	0.58	0.60	0.61	0.57	0.58	0.57
40	0.45	0.46	0.48	0.46	0.40	0.45
50	0.31	0.33	0.34	0.37	0.30	0.34
60	0.24	0.30	0.30	0.23	0.27	0.29
80	0.187	0.197	0.190	0.195	0.195	0.193
100	0.153	0.161	0.168	0.160	0.150	0.156
140	0.121	0.117	0.126	0.115	0.120	
200	0.085	0.087	0.104			

The sieves indicated in Columns A-1 and A-2 were used in the office of Hering and Fuller of New York. The ratings in Column A-1 were obtained by counting and weighing the sand grains. The ratings in Column A-2 are of the same set of sieves and were made subsequently by the speaker by measuring the diameters of the openings in the screens and applying the factor 1.10 to the sieves Nos. 10-100 and 1.18 to the sieves Nos. 140 and 200. The ratings in Column B were made by Mr. A. E. Kimberly at the Sewage Testing Station of the city of Columbus, Ohio. The sieves of Columns A and B were made by the same manufacturer, at the same time, under the same specifications. The ratings in Columns C and D

were obtained by the speaker for two nests of sieves used at Philadelphia. The ratings in Column E were determined by Mr. J. W. Ellms for the sieves used in testing the sand required for the Cincinnati Water Purification Plant. Mr. Ellms rated these sieves by measuring the diameters of the openings and applying the above mentioned factors to determine the sizes of separations.

The table serves to illustrate some of the reasons why it is believed that the subject of standard apparatus and standard methods for analysis of sands and gravels is of great importance to the engineering profession at this time.

Attention is drawn also to the marked differences in engineering specifications and requirements for the preparation of sands used for filtration purposes. Frequently such specifications are limited to an expression of the maximum and minimum effective size and maximum and minimum uniformity coefficient.

These terms mean nothing to the ordinary contractor who must furnish the material. It is obvious that the whole question of obtaining satisfactory material would be very much simplified if the specifications would read that a satisfactory sand would be one which contains not more or not less than certain specified quantities as separated by certain standard sieves. Such standard sieves would be available for the contractor, or manufacturer of the material, as well as for the engineer in charge of the work who, under present circumstances and conditions, has the matter almost entirely in his own hands. This is true in regard to specifications for sand required not only for filtering material but also for any other purpose.

It is significant that the difficulties of the present situation are appreciated by some of the manufacturers of screens and testing sieves who have, in some cases, in their trade publications, gone into a discussion of testing sieves rather thoroughly with a view of meeting the demands of the engineering profession. Special reference is made to catalogue A entitled "Testing Sieves," published by a manufacturer of Cleveland, Ohio. This company has placed on the market a set of testing sieves, the finest of which conforms to the No. 200 sieve described in the standard specifications of the Bureau of Standards at Washington, D. C. The intervals between the wires, or the diameters of the openings in the sieves, increase in a certain definite ratio, namely, the square root of 2, or 1.414. This ratio has certain obvious advantages because it permits the

selection of sieves which give accurate ratios of separations of 1.1414, 2, or 4 to 1. These sieves are described in the following table:

Standard Testing Sieves

MESH (NO. PER INCH)	DIAM. OF WIRE (INCH)	OPENING (INCH)	OPENING (MILLIMETER)
	0.149	1.050	26.67
	0.135	0.742	18.85
	0.105	0.525	13.33
	0.092	0.371	9.423
3.....	0.070	0.263	6.680
4.....	0.065	0.185	4.699
6.....	0.036	0.131	3.327
8.....	0.032	0.093	2.362
10.....	0.035	0.065	1.651
14.....	0.025	0.046	1.168
20.....	0.0172	0.0328	0.833
28.....	0.0125	0.0232	0.589
35.....	0.0122	0.0164	0.417
48.....	0.0092	0.0116	0.295
65.....	0.0072	0.0082	0.208
100.....	0.0042	0.0058	0.147
150.....	0.0026	0.0041	0.104
200.....	0.0021	0.0029	0.074

It is believed that the adoption of a standard nest of sieves along these lines by the engineering profession would help very materially in securing uniformity in the expression of results of mechanical analyses of sands.

It is, also, believed that there would be a great advantage in simplicity of expression of results of analysis or in the form of specifications covering the preparation of filter sands to the effect that 10 per cent of the sand passes, or shall pass, a standard sieve No. 35, or a standard sieve having an opening of 0.417 mm. diameter, as compared with the usual statement that a sand has, or shall have, an "Effective Size" of 0.46 mm. Moreover, the term "Effective Size" has no significance whatever outside of its application to a filter sand and of itself alone the term is of doubtful value as applied to sands such as are frequently used for rapid sand filters. The range of sizes is believed to be much more significant.

In conclusion, it is the writer's wish to call to the attention of the members of this Association that the matter of standardizing methods of making analyses of sands is of importance to all water works men who have to do with water purification problems. If contractors and water works superintendents understood more about the matter, frequently it would be possible to construct and maintain filtration plants at much less expense than is now required. The matter of obtaining satisfactory filtering material frequently is extremely simple, but has been made difficult by the methods of analysis commonly employed, and by the requirements as to size described in engineering specifications. There is no probability that the engineering profession as a whole will adopt the terms now used in the mechanical analyses of filter sands for the analyses of sands and gravels used for other purposes such as proportioning concrete, paving mixtures, etc., so that uniformity and standardization of the results of such analyses can be obtained only by a revision of present methods.

DISCUSSION

MR. PAUL HANSEN: The Association is greatly indebted to Mr. Burgess for bringing the matter of revised methods of filter sand analysis to its attention. The speaker would like, however, to emphasize that we should not discredit entirely the method that has been hitherto used. Mr. Hazen's method has been developed on scientific lines and will probably continue to be the basis for any revised standard that may be adopted. That Mr. Hazen's method has proven to be a reasonably satisfactory method for sand analysis is attested by the very fact Mr. Burgess mentioned, namely, that there has been very little literature published recently on the subject of sand analysis.

It is also questionable whether the full interpretation of a sand analysis can be reduced to such simple terms that it can be readily made by general contractors. However, there can be no doubt about the fact, that the time has come when certain modifications are desirable, especially in view of the fact that it is possible now—which was not the case formerly—to obtain sieves that are made very accurately and uniformly.

MR. F. C. LEOPOLD: There is no question but that it would cost a good many localities unnecessarily for sand used in their filter

plants by reason of the method of analysis. There are a great many localities where perfectly acceptable sand can be secured for filtration purposes and where fairly satisfactory screening plants are established. The only necessary addition to them would be inexpensive screens to secure the grade of sand necessary. But when you put certain requirements of sand analysis up to the sand producer he throws up his hands and does not want to have anything to do with it at any price; consequently, we have to pay anywhere from \$2 to \$10 a ton freight on sand that very often could have been had elsewhere at \$1.50 freight rate, or less.

It does not make any difference to the filter builder, of course, he does not have to pay it, but whoever is building the plant has to pay it. Still there is absolutely no excuse for requiring something which does not add anything to the efficiency of your plant, and which would prevent a man who can do so from furnishing you material that would adequately fulfill the requirements.

There is another thing that the speaker wants to call attention to, and that is an idea in the minds of some engineers that there are only one or two places that filter sand can come from, and that it does not make any difference whether it fulfills the requirements of their specifications or not, if it does not come from those points it is not satisfactory filter sand. We have found that in our experience, not once, but a number of times, we have been able to produce sand that would fulfill in every way the requirements of the specifications, but because certain filter sand had been demanded, as that or its equal it did not comply with their specifications, necessitating an additional expense anywhere from \$2 to \$10 per ton freight rate, which is absolutely unnecessary. The speaker fully agrees with Mr. Burgess in his idea that something ought to be done to eliminate the necessity for paying freight rates unnecessarily on sand for this purpose when it can be gotten locally, and just as efficient in every way.

MR. WILLIAM M. JEWELL: There is no doubt that a great saving, as Mr. Leopold said, can be made in the water works filtration plants by changing to the standards that Mr. Burgess has recommended, and the average sand contractor is very much befuddled over terms which he can never understand, because he has had no technical education; and furthermore, such requirements do not always seem to have a legitimate basis.

Experience has shown that if the uniformity coefficient was based on a higher percentage, say 40, it would be very much better for mechanical filters of rapid type than if based on 10 per cent of the finer material.

In rapid mechanical filters, the washing of the filters is getting down to a point where from three to four minutes' application of water is supposed to be sufficient; and the more we can approach an ideal or uniform size of sand, the better it is going to be for efficiency, when you come to shut off the wash water and restart your filter, you are not going to have a mixture all through the filter bed or the fine material on top. As Mr. Burgess has well said, a standard of 10 per cent effective size is all right for slow sand filters, but it is a little bit out of date. The speaker agrees with Mr. Burgess that the standards ought to be changed.

MR. GEORGE W. FULLER (by letter): The writer is in sympathy with Mr. Burgess' viewpoint in the effort to secure simplification and standardization of sieves used for the mechanical analysis of sands.

Unquestionably it has been a fact in the past that contractors, sand dealers and others have experienced marked difficulty in knowing what was desired by engineers who specified the effective size of sand, uniformity coefficient, and limitations in quantities of sand particles either above or below a stipulated size expressed in fractions of a millimeter. Any procedure which will materially improve this situation, as handled by large numbers of people who now grope more or less in the dark, should certainly be welcome.

On the other hand, it should be kept clearly in mind that methods of measurement used for a period of 20 or 25 years should not be put aside lightly until important practical experience gained in past years, with more or less unsatisfactory methods, can be translated for the benefit of the technician with substantial certainty into terms of the new and improved method of measurement which it is desired to adopt.

It is the belief of the writer that the methods can be improved without sacrificing materially our practical grasp of the significance of the fund of knowledge accumulated in the past.

MR. WM. B. FULLER (by letter): The author has brought to the attention of the writer a matter which has for several years occupied his thoughts, and he is in hearty accord with the suggestion

toward the abolition of specifications concerning effective sizes and uniformity coefficients, and the adoption of language more easily understood by contractors and others who have to furnish the materials.

In specifying sands for filter plants, and in mixing concrete, the writer has long since abandoned these confusing terms, having discovered that they acted as bugaboos to the contractor, who, in consequence, bid much higher than was necessary, for fear of money losses, due to possible impracticable enforcement of petty details.

The writer has no doubt that many thousands of dollars would have been saved to communities had all specifications been written so as to state the allowable percentages passing through certain standard sieves. In the absence of such standards the writer has been accustomed to specify the percentages passing a certain number of meshes per lineal inch made from a certain size wire. It is obvious that if a standard mesh was adopted the specifications would become clearer and less cumbersome. Experience in this line leads the writer to believe that the community would receive the benefit of lower costs for equally good work.

The writer is fully in accord with the author's views that, within the limits of such accuracy as can commonly be secured in making a mechanical analysis of sand, a constant ratio can be adopted between the size of separation and size of opening; his own experience leads him to believe that the personal equation of the operator, the methods, and rate of shaking, and other factors, will produce greater variations in the calculated rated sizes, than would be produced by the use of standard sieves by different operators. Great care and thought, however, should be expended by many persons familiar with the use of test sieves before a definite standard should be adopted.

The recommendation of the author towards the adoption of the standard proposed by the Cleveland manufacturing firm should be carefully considered, as the system is very inconsistent in many respects, not the least of which is the fact that such sizes have been selected for the cloth as are not of standard make, and, in order to maintain the openings in a constant ratio, the ratio of width of wire to width of opening is very erratic. This is particularly noticeable with their 6 and 10 mesh and their 28 and 30 mesh.

The writer considers it very necessary for standard sieves that not only the openings of adjacent sieves should bear some definite

mathematical relation to each other, but also that the ratio of width of opening to width of wire should bear some ratio, and, more important than all, the standards adopted should be of weaves from standard sizes of wire. Most wire is now drawn to either the old English or the Brown & Sharp gauges, and, in addition, only certain of these gauge sizes are available to the trade without special orders for large quantities. Standard sieves should therefore be made from stock wire, if possible, otherwise but few firms could afford to keep a stock of wire for this particular purpose, and as a consequence, many sieves would be sold which were not standard.

In connection with standard sieves, it is also necessary to adopt standard methods of shaking, and in this line a mechanical agitator, giving both a semi-rotary and undulatory motion, is desirable.

The writer is of the opinion that the ratio of one sieve opening to that of the next smaller size in the same series should vary gradually through the series from a larger ratio for the larger openings, to a smaller ratio for the smaller openings, and that at the same time the ratio of the size of wire to the size of opening used in any sieve should gradually decrease as the openings become larger.

It would be very desirable that this matter of standard sieves should be taken up in coöperation with the Bureau of Standards of the Department of Commerce at Washington, and with the American Society of Testing Materials, who it would seem would be the logical society to promulgate a standard, as any standard adopted should be adjusted so as to be of use in all industries.

MR. ALLEN HAZEN (by letter): It may be that when one has proposed a method that has been in very general, in fact, in almost universal use among those having to do with the subject for a period of twenty to twenty-five years, he ought to be willing to see the method discarded and replaced by a newer one. The writer is in this position with reference to the method of mechanical analysis, which is the subject of Mr. Burgess' paper. However, he feels disposed to insist that it be demonstrated that the proposed changes represent a real advance before they are adopted, and in the present case he feels that some of the changes suggested by Mr. Burgess would be unfortunate, and would not mark an advance in the art.

Mr. Burgess speaks of the necessity of having the standards equally applicable to all the various purposes for which mechanical analyses are required. In this the writer fully concurs. The same definition

of size of particles should, if possible, be used in discussing very fine sediments and silts; in discussing materials to be used as foundations; in discussing filter sands; in discussing materials for concrete mixtures, and in discussing materials for asphalt mixtures.

We can here, perhaps, well divide the subject into two parts. In the old method of sand analyses developed by the writer, the size of grain was defined in all cases as the diameter of a sphere of equal volume. This method is an absolutely general one, applicable to all cases, and the writer sees no reason why it should be abandoned at this time.

The second part of the subject relates to the terms "effective size" and "uniformity coefficient." It should be understood that these terms were originated for the purpose of defining filter sands and for no other purpose, and it is to be recognized that they are not necessarily or presumably applicable to discussing sands, gravels or silts for other purposes. If they prove to be useful for some other purpose, there is no reason why they should not be used, but there is no presumption that they have any significance whatever with reference to materials for foundations or asphalt mixtures, or sands and gravels for concrete.

Mr. Burgess' principal proposition relates to the first part. He proposes to abandon the use of sizes of particles which pass or fail to pass the screens, and to substitute therefor the size of mesh of the screen itself.

It may be proper at this point to state that the method of rating sieves originally proposed and in general use is to put a representative sample of sand upon the sieve to be rated, to shake it in a specified manner, and at the completion of such shaking, to give it a slight further shaking, during which the material passing is separately caught, and finally to determine the grain size of these last particles. Experience shows that these particles are nearly all of the same size, and when that size is determined it establishes the size of separation of the sieve. The size of the particles, in most cases, is determined by weighing a certain number of them and computing the average weight, and from that the average volume and the diameter of a sphere of equal volume, which is the basis of the statement. This is a process that can be carried out with quite definite results, and it is the foundation of the whole scheme of rating and grain sizes that has been used.

In practical operations, a method of comparative rating is also

used and has been found helpful. By this system, one set of sieves, dedicated to that purpose and rated with the utmost care by the method first described, is used for comparison with other sieves for which ratings are desired. The same identical sample of sand is sifted through the standard sieves and through those to be rated. This is repeated with several samples of sand selected to show the points of separation of the respective sieves.

The results of the analysis of each sand by the standard sieves are plotted on logarithmic paper, 20-inch base, a large scale being used to allow of the utmost precision. It is found that the analysis of natural sands plotted in this way, including about the finest half of the material by weight, plot in nearly a straight line on this paper and it is possible from the sieves in the standard set to get a very accurate determination of the position of this line at all points. With this line plotted, the percentages of materials passing each of the new sieves are found upon it, and in the opposite direction is found the corresponding size of separation for that sieve.

The size of separation determined in this way is determined with reference to the original or standard sieves. Very great precision is obtainable with careful manipulation. For instance, the difference between a sieve having a separation 0.200 mm. and one having a size of separation of 0.205, should be unmistakably apparent. This degree of accuracy is all that is required for practical purposes.

This method of comparative rating is described at some length, because it has an important bearing upon the question of substituting the size of mesh for the size of separation of the sieve. The size of mesh is computed in a somewhat theoretical way by ascertaining the number of meshes per inch, best obtained by counting blue prints made from the wire cloth, by measuring with a micrometer the diameters of the wires and by computing from these data the average openings in the two directions. They are practically never square. The wires differ in diameter by quite appreciable amounts among themselves and no one has yet found how to weave cloth so that the space between successive wires is always the same. Under these conditions, some openings are larger and some smaller than those computed, and the majority of holes, instead of being square, are more or less out of square.

The particles of sand instead of being spheres are irregular in shape, the long, middle and short diameters for ordinary sands being

approximately in the ratios of 4, 3 and 2. When such ordinary sand grains are shaken upon a mesh that is not quite square, it is found that the size of grains passing is determined by the longest dimensions of the mesh and not by the shortest one. In other words, if the mesh is 0.28 mm. in one direction and 0.30 mm. in the other direction, it is the 0.30 that controls, and the size of separation of such a sieve will be substantially the same as of another sieve 0.30 in both directions, and also substantially the same as the size of separation of sieve 0.30 x 0.25. This is not exactly true, but it is approximately so.

However, even when this matter is taken into account, there are always variations in the sizes of the openings that affect to an appreciable extent the size of separation of the sieve. For instance, if from a very carefully woven piece of wire cloth, woven for the express purpose of making sieves, and with the greatest attention to having it uniform throughout, a dozen pieces are cut close together and made into sieves and examined by the system of comparative rating mentioned above, substantial differences among the sizes of separation of the sieves are invariably found. These differences are not accidental, such as might be accounted for by differences in manipulation. They are real differences that can be substantiated by passing any number of samples of sand through the same sieves and concordant results can be obtained.

Under these circumstances, to abandon a definite and quite accurate method of designating the size of the sieve and to substitute therefor a less accurate method, is certainly not a step in advance. Examinations of various other kinds of materials involve much labor and equipment. If accuracy is to be secured in such examinations, it is imperative that the fundamental ideas upon which accuracy is based should not be neglected nor abandoned.

It is further to be noted that sifting is only one of various methods used in determining the size of particles. For instance, it is not practically applicable to particles much less than 0.10 mm. in diameter. For all smaller particles elutriation or microscopical methods must be used. Such small particles have little significance in filtration work, but in studies of materials for other purposes they are exceedingly important, and it seems desirable to the writer that the method used should be a general one that does not need to be varied for different purposes. The size of sieve opening being

about 90 per cent of the size of particle, it would be necessary, in order to keep the results consistent, to use an expression to describe the size of smaller particles something like this:

Size being about 90 per cent of actual size and taken to represent what the size of sieve would be which would pass particles of this size, if such a sieve could be made and used.

Similar definitions would be necessary to describe larger particles separated by round openings in metal discs, which are more convenient and accurate for particles 2 mm. and over in diameter.

The writer is interested in Mr. Burgess' statement that the term "effective size is not entirely satisfactory, because the range of sizes of sand permitted in rapid sand filters frequently is very much less, etc." The writer begs to point out that this is precisely the point where the uniformity coefficient is useful. The need of having some method of expressing the degree of variation in the sizes of the particles of sand was recognized when the present method of sand analysis was devised, and it is no less essential now than it was then. In the light of all the experience in twenty-five years since, and with a study of recent development in the art of statistics and methods of statistical expression, the term "uniformity coefficient" seems to measure up very well to modern standards. It is possible that the words "uniformity coefficient" could be now improved upon. On the other hand, the modern equivalent "coefficient of variation" has a precise definition and it should be used only for exactly what it is defined to mean in books of statistics.

The data of sand analysis cannot be treated in a way so that the "coefficient of variation" can be easily computed. The "uniformity coefficient," however, which is easily determined by the methods now in common use, would be proportional to the "coefficient of variation," if that could be computed, and is equally as useful in the interpretation of sand analyses, and as long as it is not identical, it seems better to retain a distinctive expression for it.

The effective size was defined as such that 10 per cent by weight of the particles were smaller than it. This has seemed to many as a somewhat arbitrary and rule of thumb procedure. However, it was based upon very good underlying data.

The filtering materials for which data were available at Lawrence when the method was adopted comprised sands with quite a wide range in uniformity coefficients. Data for frictional resistance, capillarity, etc., for these sands were available. Comparative studies

showed that if 8 per cent was taken as the limit instead of 10 per cent, an unduly great weight was given to the effect of the finer particles upon the physical properties of the material; while if 12 per cent were taken, the effect of the finer particles was inadequately represented. The Lawrence data were very clear upon this point, and the 10 per cent limit was selected because this brought all the materials for which data were then available into their correct relative positions with respect to frictional resistance and capillarity.

There is no reason to suppose that 10 per cent is a precise mathematical limit always true of all materials. Nevertheless, practical experience extending over twenty-five years and to many thousand samples of sand and the collection of large amounts of additional data on physical properties, has failed to show any way in which the original expression could be improved in a substantial manner.

The writer is interested in the improvement in the methods of weaving cloth for sieves and of the suggested arrangement for a set of standard sieves. The arrangement proposed seems an excellent one, and if it can be carried out to give sufficient regularity in mesh opening, he would heartily support it, but would urge that the sieves nevertheless, be rated in all cases and that the actual size of separation be used in discussing the results, rather than the supposed size of separation computed from the nominal or even the measured average mesh and size of wire.

The writer also notes the suggestion that engineering specifications should be written so as to provide the percentages that should pass sieves of certain sizes. Mr. Burgess has evidently overlooked the fact that all the earlier specifications for sand and gravel drawn in the writer's office, and frequently copied in other early specifications, were drawn in the way which he now proposes. For instance, the Albany filter specifications required that, "The grains . . . shall be of the following diameters; not more than 1 per cent by weight shall be less than 0.13 mm. nor more than 10 per cent shall be less than 0.27 mm.; at least 10 per cent by weight shall be less than 0.36 mm., and at least 70 per cent shall be less than 1.0 mm. No particles shall be more than 5.0 mm. diameter."

The method was a perfectly satisfactory one and has much merit. As the years have gone by and contractors have become accustomed to the terms "effective size" and "uniformity coefficient," these have been written into the specifications and have taken the place of the longer schedules which had previously been used. The writer

thinks that very little practical difference has been made in this change. No doubt, it is true that many contractors do not fully understand all the nomenclature of sand analysis. That is true of many other parts of our specifications.

After much experience in securing sand under specifications covering, perhaps, the purchase of as large a quantity of sand and at as low an average price as would be represented by the experience of any other office in the country, the writer is unable to say that lack of understanding of these methods by contractors has been a serious obstacle in the prosecution of the business. It is certainly true, as Mr. Burgess suggests, that there are numerous excellent deposits of sand stock all over the United States that have not been used, and that much money could have been saved by more knowledge and better appliances. However, that is hardly the fault of the method of sand analysis. A general raising of the intelligence and information of those who have to do with this subject must be the foundation of improvements in this respect and of a more complete use of natural resources.

MR. PHILIP BURGESS: Before presenting this paper to this Association, the speaker submitted a considerable number of copies to engineers interested in the subject with requests for their opinion in regard to the subject matter contained in the paper. He was interested to note that in nearly all cases these engineers concurred in the opinion that the methods now in use for analyzing sands and the specifications frequently used by engineers to describe sands may very well be revised, simplified, and standardized. It is, of course, true that any step towards a revision of standards or methods of testing, which have been generally adopted for long periods of time, should be taken slowly and only along the lines approved by the majority of those interested and affected.

Nearly all of the engineers who have expressed opinions in the preceding discussion and otherwise have agreed that the use of terms such as "effective size" and "uniformity coefficient" in engineer's specifications is not to be recommended because these terms are not understood by the manufacturers or contractors who have to supply materials in accordance with such specifications. There remains, therefore, but two possible methods of describing sands or gravels in regard to their size or range of size, namely, by specifying certain definite ranges of sizes of grains or by specifying certain definite

percentages by weight which may be retained upon or pass certain standard sieves. At the present time there are no such standard sieves so that it is necessary to define the range of sizes of grains or particles.

It is, therefore, true that specifications along the lines of certain percentages by weight to be retained upon or to pass certain standard sieves would be a radical departure from current practice which specifies sizes of particles regardless of size of openings of screens through which such particles may pass. It is this departure from current practice which, of course, should be approached with hesitancy and assurance of advantage before it is taken.

The speaker has called attention to specifications of a certain set of standard sieves which define the sizes and spacings of the wires with a view of illustrating what in his opinion is required at this time, namely, a standard nest of sieves for making mechanical analyses of sands. He does not wish to be understood as arbitrarily recommending the adoption of this particular set of standards although the use of a definite screen ratio has obvious advantages. Mr. Wm. B. Fuller has called attention to certain features of these standards which are objectionable, and especially to the fact that there is not a definite ratio between the sizes of openings in the meshes and the diameters of the wires. As Mr. Fuller very well states, this ratio is important and affects the ratio of the size of separation of a sieve to the average opening in the sieve. It is doubtless true that, in any standards that may be adopted, it will be desirable to maintain as closely as possible a definite relation between the size of opening and diameter of the wire in each sieve. As Mr. Fuller also states, the standards adopted should be based upon wire cloths which are readily attainable from manufacturers.

Mr. Wm. B. Fuller and Mr. Hazen both have called attention to the causes of differences in the determination of the size of separation of a sieve; such differences may be attributed to differences in the sands used for rating; in the personal equation; in the method and rate of shaking, and in other factors. Mr. Hazen very well states that it is possible to obtain very accurate precision in determining the separations of sieves by using careful manipulations; and that, for instance, a difference between a sieve having a separation 0.200 mm. and one having a size of separation of 0.205 should be "unmistakably apparent." The speaker agrees with this statement provided that it is qualified to refer to the use of the same sand by

the same operator using always similar procedure. However, this, of course, is not universally the case, because different operators must use different materials composed of sand varying from sharp to round grains, and because operators do not now use the same procedure and care in obtaining the sample of sand selected to represent the separation of the screen. In other words, in present practice there are introduced two important variables, the one due to different materials, the other due to different manipulations of materials.

The fundamental assumption which is made in rating a sieve is that the sand grains are spheres. This, of course, is not true. Moreover, in some cases, the grains do not even approach spheres. Consequently experience indicates that there always are differences in the sizes of separations of a sieve depending upon the material selected to standardize and rate the sieve. Such differences frequently will amount to very much more than 0.005 mm. mentioned by Mr. Hazen to be "unmistakably apparent."

In order to obtain the accuracy mentioned by Mr. Hazen it is necessary that the sieves be rated with the materials which are to be analyzed.

Mr. Hazen refers to a comparative method of rating sieves which consists in determining the sizes of separations of a set of sieves from a determination of the percentages of separation of a sand which has been previously analyzed by a standard nest of sieves. This, of course, is true whether the size of opening or the size of separation of the sieve is used as a standard of measurement, and does not affect the point at issue.

It is a well known fact that it is not physically possible to manufacture wire cloth containing wires of absolutely uniform size and with absolutely uniform spaces between the wires. Consequently, it is argued that it is not practical or feasible to determine the size of separation by an examination of the cloth to determine the average size of openings. This criticism is undoubtedly true for the very fine wire cloth, but is not thought to be well taken for the comparatively coarse cloth containing 100 or less meshes per inch. It is possible today to obtain the coarser wire cloths woven with sufficient accuracy for all practical purposes.

Mr. Hazen argues that it is not a step in advance to change the standard of measurement from the size of separation to the size of opening because of the fact, as stated above, that the size of open-

ing is a variable, and because the larger openings determine the size of separation of a sieve. This point is well taken so far as it applies as a standard of measurement, but as above stated, it is the speaker's thought that even a greater variable is introduced by using the average diameter of the sand grains due to the fact that these grains seldom are round although they are necessarily assumed to be round in determining the size of separation of a sieve. This error of measurement is believed to be much greater than the error of measurement which might be assumed by determining and using the average diameter of the opening in the wire cloth.

In conclusion, it is believed that the matter may very well be handled in the same manner as has been used by the Bureau of Standards at Washington, D. C., in standardizing cement sieves. This bureau has recognized the fact that the standard 200 mesh sieves as required for cement testing are not uniform, and the bureau has coöperated with 80 laboratories throughout the country to determine the sieving value of the 200 mesh sieves, as used for cement testing. As the result of these experiences, the Bureau first drew up specifications defining the 200 mesh sieve in terms of the sizes and spacings of wires and permissible variations. Subsequent experience indicates, however, that the average opening in a sieve does not necessarily determine its sieving value, so that subsequently, the bureau revised its specifications to include a sieving value based upon certain standard material. At the present time, a standard of fineness has been adopted and standard samples of cement to be used for rating 200 mesh sieves are available at a cost of 25 cents to any one who may desire to check up his 200-mesh sieve.¹ The samples of cement are guaranteed to within 0.2 per cent on the fundamental standards of the bureau. This method of rating is in effect the same as the comparative method of rating sand sieves described by Mr. Hazen.

The speaker can see no reason why a similar method of obtaining standards may not be developed for use in connection with the coarser sieves used for the mechanical analyses of sands. It remains for the engineering profession to determine what sieves may properly be adopted as standards and to solicit the coöperation of the Bureau of Standards in this work. If such a set of standard sieves is adopted

¹ Reference: Technologic Paper No. 42—Bureau of Standards, Washington, D. C.

and if the sieves used by laboratories throughout the country are rated in this manner, it is a comparatively immaterial point whether the standard of measurement used is the size of opening or the size of separation. It is, however, very important that the method of obtaining satisfactory standards be available to every one interested.

Moreover, if such standard sieves are adopted, engineering specifications may be simplified to read in terms of these standards thus eliminating all ambiguity and indefiniteness of meaning.

The speaker is very well aware that Mr. Hazen, Mr. Fuller, and other engineers frequently prepare their specifications for filtering material to read in terms of sizes of grains avoiding the use of the terms "effective size" and "uniformity coefficient." However, it is undoubtedly true that the majority of rapid sand filter plants have been and are being constructed under specifications which contain these terms defining filtering material required. The same thing is true relative to filtering material which is purchased as required to maintain filter plants in operation after completion. Standard apparatus or method of analyses of filter sands certainly would be helpful in many cases in producing satisfactory material at the least cost.

It is somewhat remarkable that so little work has been done to determine the hydraulic values of filter sands and that the results of experiments obtained some 25 years ago have been almost universally accepted and adopted. The speaker is convinced that the term "effective size" as now used is of questionable value; in fact, it is his belief that the hydraulic value of a sand depends upon the average size of the particles and the uniformity of the material and not alone upon the size of the finest 10 per cent of the material.

However, it is not so much the thought to discuss the value of these terms at this time as to call to the attention of the engineering profession the necessity for adopting standard methods of analyzing sands used for all purposes. The necessity for such standards is universally recognized, and it is the speaker's opinion that it is a matter of a comparatively short time until such standards will be adopted.

STATE REGULATION OF MUNICIPALLY OWNED PLANTS¹

BY C. M. LARSON²

The real functions of a regulating body whether centralized as a state commission or localized in the common council or a local commission are very generally misunderstood. This is especially true if the plant under consideration is owned by a municipality. The proper regulation of any utility embraces two broad subjects: that of service and that of rates. The question of propriety of regulation of municipal plants will be much more readily understood if it be borne in mind at all times that the question of service to be rendered by a utility is of more importance than that of the rates charged. The primary purpose for which all utilities, private and municipal, are in existence is that of giving service to the public, the question of rates to be charged is of secondary importance. It must be insisted that the first duty of a utility is to furnish adequate service, even though a poorer service might be furnished at a lower rate.

It appears to be the general conception that the regulation of profits of a public utility is the prime function of a commission, and that, after the profits have been reduced to a reasonable amount, the services of the commission are no longer necessary. This conception is erroneous, but even if the question of profits alone were the only matter to be considered, the commission's duties are far from finished when the earnings of a utility plant are so adjusted that the total profits are no more than a just return upon the fair value of the property. The utility may be earning only a fair profit, or even less, and still the rates to certain individuals or class of individuals may be far from equitable. The problem of construction of schedules that will be equitable as between the various individuals and classes of consumers is a much more difficult matter than the regulation of total profits. To be equitable the schedules should be so arranged that each consumer is required to meet as nearly as possible his just

¹ Presented at the Annual Meeting of the Illinois Section of the American Water Works Association, Urbana, Illinois, March 10, 1915.

² Chief Engineer, Railroad Commission of Wisconsin, Madison, Wisconsin.

and proper share of the expenses of the utility. If the schedules are not so adjusted some consumers are actually paying for the service supplied to others. The removal of discrimination from the schedules of a utility plant is one of the hardest problems with which a regulating body has to deal. This applies as well to private plants as to municipal plants, but in the latter we often have more serious discrimination than in the former. Elimination of discrimination from schedules requires the most searching investigation by men of scientific training and practical knowledge of operating matters, and involves a recognition of the fact that certain costs are incurred as soon as a consumer is connected to the system, regardless of whether or not he makes use of the service, and that a minimum charge should be made to cover this, to which should be added a charge for the service actually rendered, this latter to be based upon the cost of rendering this service. Local managements do not always recognize the importance of these principles, and even if they do recognize them, they are often unwilling or unable to put them into effect. The question of equitable rates is in reality a very complicated one, and the employment of a person who is expert enough in rate matters to construct a schedule based upon a proper consideration of all items that should influence a decision in so important a matter is usually quite beyond the financial reach of small plants. Where is the small utility to turn for assistance at such times? Shall it maintain its so-called independence and continue to go on as before, obtaining indifferent success because nobody is able to offer something better, or because consumers or taxpayers are loath to make complaint of a plant in which they have an interest?

Let us see the results of such procedure. The commission in Wisconsin requires that each utility submit schedules of rates for approval. A great many so submitted are based on erroneous principles, as noted in the following case: In January, 1913, a municipality submitted the following schedule for water rates:

1000 gallons or less per month.....	\$0.60 per 1000 gallons
1000 to 2000 gallons per month.....	0.50 per 1000 gallons
2000 to 3000 gallons per month.....	0.40 per 1000 gallons
3000 to 4000 gallons per month.....	0.30 per 1000 gallons
Minimum charge \$7.20 per year	

This schedule appears to be based on equitable principles; apparently there is a fair minimum charge and the rates to the consumer

decrease as his consumption increases, but if these rates be plotted into a curve there at once appears a woeful amount of discrimination. If consumers "A," "B," and "C" use 2000, 2500, and 3325 gallons respectively, they each pay one dollar per month. If "A" who pays one dollar for 2000 gallons uses 2100 gallons, he falls into the second group and pays only 84 cents. Therefore by consuming 2100 gallons instead of 2000 gallons his bill becomes 84 cents instead of one dollar.

The above is simply an illustration recited as a type of what the smaller plants, whether private or municipal, must contend with largely because of inability to employ expert advice.

According to the annual returns received by the railroad commission from utilities in Wisconsin for the year ending June 30, 1914, we find that there are 196 electric plants privately owned and 72 electric plants owned by municipalities. All of those owned by municipalities with one exception are in towns, villages and cities with a population of less than 10,000. Reports from the water companies of this same date show that there are 26 plants owned by private parties and 163 by municipalities. No telephone companies are owned by municipalities in Wisconsin and municipal gas plants are of minor importance as only the small acetylene or gasoline plants are municipally owned. Thus it is seen that in the electric and water business there is a total of 222 privately owned and 235 municipally owned plants in the state. Several additional plants were built in the state during the year which received the attention of our inspectors but which did not make the regular annual report.

SERVICE

The public utilities commissions in several of the states, including Illinois and Wisconsin, have issued rules of service for gas and electric properties. Efforts have also been made to prescribe equitable service requirements with respect to the operation of water plants and tentative rules have been drawn in Wisconsin, but thus far no definite instructions have been issued. In all branches of utility service, however, high standards have been insisted upon, whether definite rules are published or not. Briefly these requirements are, in the electric business, a relatively constant voltage to be maintained at all times when required by the consumers, accuracy of meters, reasonable business methods and above all no dis-

crimination either in favor of or against any consumer. For water service, an adequate supply of good pure water, accuracy of meters, adequate provision for fire protection, and as in the electric business, reasonable business methods and no discrimination. Requirements for service in the gas business are based upon the same general consideration, with the addition of standards for heating value, limitations in pressure variations, and quality of the gas.

In order that the commission may be kept informed at all times respecting compliance with standard requirements in the various plants, the state has been divided into several districts, and an engineer placed in charge of each district whose duties include periodical visits to all plants, for the purpose of checking up service in each, and also for the purpose of offering such advice as possible where this seems necessary.

During the year ending June 30, 1914, these engineers made 209 inspections of 170 of the privately owned electric plants and 94 inspections of the 76 municipally owned electric plants, making an average of about 1.2 inspections per plant. No regular service inspections of water plants are carried on in Wisconsin. In the investigations made by our inspectors, not only of complaints but of routine service matters, it is found that the rules and regulations laid down by the commission are being violated continually by municipal as well as by private utilities and it is necessary to follow up these inspections from time to time in order to impress upon the operators the importance of rendering such service that full compliance with the rules will result. These violations are most often in the nature of excessive voltage or pressure variation, low heating value of gas, failure to test meters within the proper time, etc.

The following brief review of inspection records of a typical small municipal electric plant gives an idea of the developments from the first inspection to the present time:

This municipal plant was first inspected in March, 1909. Two single phase generators supplied the service to 180 consumers.

An inspection in December, 1909, showed that the utility was not fully complying with the meter requirements, although satisfactory voltage regulation was being maintained.

An inspection in June, 1910, showed that the meters had been tested, as required, but that there was excessive variation in three of the six localities where records were taken. Several interruptions in service had occurred on account of the same trouble. Installation meter tests were not being made, as required.

An inspection in September, 1910, showed three of the four voltage records outside of the allowable limits.

An inspection in October, 1911, showed the voltage regulation to be unsatisfactory, the meters had been neglected and the master meter was found to be in unsatisfactory condition for use.

An inspection in June, 1912, showed that the voltage variation was even worse than that formerly reported and that meter testing rules were still receiving practically no attention. There have been several changes in management of this plant, but in June, 1912, the new manager reported about one-half of the meters tested.

In October, 1912, substantially the same conditions prevailed.

In January, 1913, a follow-up inspection was made which showed that no meter testing progress had been made. The superintendent gave as his reason that he had too many duties in connection with the plant operation to take care of these matters. After taking this up with the mayor another inspection was made in April, 1913, which showed that the majority of the meters had been tested and that there were still many interruptions in service. No voltage records were taken at this time. All meters were reported tested in June, 1913.

An inspection in September, 1913, showed that they are in need of additional station capacity in order to properly take care of the winter load.

In November, 1913, it was found that a new engine was being installed.

In March, 1914, an automatic voltage regulator and other equipment were ordered.

An inspection in March, 1914, showed satisfactory regulation in some sections of the system, although there was excessive variation in others. About 40 per cent of the meters were due for test.

An inspection in January, 1915, showed that some 90 meters were due for test out of a total of 280. Interruptions in service had been practically eliminated and the voltage regulation substantially improved, although still outside the requirements in some localities.

On one occasion an inspector reached a municipal plant within a few days after its one engine had broken down and the lighting business had been entirely discontinued. Upon inquiry he discovered that it was the intention of the village to keep its plant closed down until a new engine could be purchased and installed. He immediately made inquiries in the neighborhood, found a traction engine that was available, had this installed and electric service supplied the village within 24 hours. This traction engine carried the load successfully, though of course not very satisfactorily with respect to voltage regulation, until the new engine was purchased and the service again placed on a substantial basis.

In another instance complaint was brought before the commission of the condition of the water supplied by a municipal water plant in

a large city. After investigation the commission decided that it was necessary to seek an entirely new supply. The water had been taken from a river and pumped into the mains without filtration. The commission made extensive investigations and discovered that a very satisfactory supply of water could be obtained from wells driven on some vacant land within a short distance of the city. The city was required to purchase this land, drive the wells and install a new pumping system with the result that it now has a very good sanitary supply of water.

As an illustration of the variety of subjects which must be dealt with by each plant the following brief summary is submitted of the work carried on by one of the district engineers during one month late last year:

The inspector visited Mineral Point where a routine electric service inspection was made, including the taking of four voltage records by means of a recording instrument installed in each of two localities. A complete inspection of the meter and station records for the past year and a half was made and three persons were interviewed regarding electric service matters. A detailed report was made of considerable new electrical construction work. While in Mineral Point two telephone utilities were inspected, data collected regarding the equipment and operating conditions of each for the state telephone directory, as well as a report regarding the compliance of each company with the various rules of telephone service. Data were also collected for the water works directory.

While the recording instruments were still connected at Mineral Point, the inspector checked up the service conditions at Linden which included the meter operating records of the electric utility, the checking up of telephone service conditions and the collection of data for the water works directory. While in Linden the inspector received an informal complaint regarding the routing of telephone toll messages and controversy between the disputing companies was partly adjusted by the inspector and the questions which he was unable to settle in the field were reported to the commission for further attention.

Dodgeville was next visited where routine electric and telephone service inspections were made and the data for the water works directory collected.

A formal investigation regarding the service of the Leeds Farmers' Telephone Company necessitated that the inspector meet with the stockholders and directors of this company at an inland town 8 or 10 miles from the railroad at which time several hours were spent in discussing in open meeting the various solutions of the difficulty pending to determine as far as possible which of the several possible solutions would best suit the subscribers. After this meeting the inspector made definite recommendations regarding the telephone engineering features involved. This matter was handled on a Saturday and was not far from headquarters.

During the following week routine electric, telephone and water works matters were covered for Hazel Green, Benton, Cuba City and Shullsburg.

It was also necessary for the inspector to visit Galena, Illinois, where the main offices and plant of the Interstate Light & Power Company are located. This utility supplies the service in Platteville, Shullsburg, and to many mines in Wisconsin, and sells current to the municipalities of Hazel Green, Benton and Cuba City that supply service within their own limits.

On the following Monday the inspector returned to his routine work in the southwestern part of the district, visiting Platteville where one routine electric and two telephone service inspections were made, including the various phases of the work handled above. Eight voltage records were taken in Platteville and the records summarized for the past 10 months. Data for the water works directory were also collected in this city. The inspector also investigated the origin of two fires which were caused by high potential wires coming in contact with secondaries entering buildings. This was made upon informal complaint by the president of the Business Men's League, who requested the inspector to make the investigation stating that he had just sent a letter to the commission requesting that this be done.

The inspector next visited Lancaster and checked up the routine matters in connection with one electric and two telephone utilities. This involved the description of the equipment and practice of seven telephone centrals; also report regarding construction of transmission lines by the Lancaster utility. Water works directory data were also collected.

Fennimore was then visited where the routine work was carried on in connection with one electric and three telephone utilities. Material for the water works directory was collected and local conditions regarding a formal complaint on electric service, rates, etc., were investigated. A routine inspection was made at Belmont covering electric and telephone utilities, and Dodgeville was again visited on the way to headquarters to check up the complaint of a consumer alleging inadequate and interrupted power service. This complaint had not reached the commission in time to be investigated at the earlier visit to Dodgeville.

During the following week two days were spent at Muscoda in connection with the routine electric and telephone inspections. Investigations were also made in connection with a formal telephone service complaint after which recommendations were made regarding the decision in the case. Several meters were tested to acquaint the local superintendent with the commission's method of testing and to investigate an informal complaint regarding the accuracy of a certain meter adjustment for assumed over-charge of a meter which the inspector found to be accurate. Another informal matter handled in Muscoda was in connection with an alleged discriminatory rate charged the railroad company for lighting the depot. In addition to the above matters handled in the field, the inspector spent two days on office work writing up reports and looking over records of previous inspections.

In all cases a part of the engineers' work consists of investigating as to the manner in which each utility is complying with the various rules, together with suggestions and instructions respecting them as well as respecting efficiency, safety, etc.

RATES

The principle now appears to be pretty well established that rates should be based primarily upon the cost of service. A thorough understanding of the operating conditions of a plant must therefore be obtained before any determination of the proper charges for service to a consumer can be made. Before reasonable cost can be ascertained it is necessary that the investigating body have accurate detailed operating cost records of the plant under consideration, comparative cost records of plants operating under similar conditions, and a thorough understanding of the local conditions surrounding each plant.

The importance of these considerations was early recognized and shortly after the public utilities law became effective in 1907, the Railroad Commission of Wisconsin ordered all utilities to keep accounts according to certain prescribed forms. The forms required vary with the class of utility and with the size of the community served. In general, class A reports are required from cities of 10,000 population or over; class B reports from cities with a population of from 3000 to 5000; class C reports from cities with a population of 1800 to 3000; class D reports from cities and villages with a population of 700 to 1800; and a report called the "condensed" report for utilities in towns and villages having a population less than 700.

The following is quoted from an unpublished report recently made by the statistical department of the railroad commission. It sums up briefly the purposes for which the uniform classification was inaugurated:

The uniform classification of accounts prescribed for the utilities of the state is designed particularly to meet the needs for rate making purposes. The main object of this system of accounts is to so group the operating expenses that the cost for different consumers and classes of consumers can be determined. Each class of service incurs certain expenses. The requirement in the accounting procedure, therefore, is to segregate and apportion the operating expenses as far as practicable among the classes served. Certain expenses may be charged directly to the service for which they are incurred, and other items which cannot be so distributed because they are common to two or more services are placed in classifications by themselves so that when the question affecting rates arises they can be distributed over the respective classes by the rate fixing body, according to known facts and established principles. Unless the accounts of the utility under consideration have been kept in accordance with the principles of cost accounting, the cost of service for the respective consumers cannot be determined. Any other basis for the determination thereof would result merely in individual opinion and estimates.

A great deal of objection is raised by municipalities in Wisconsin against those requirements for the keeping of uniform records, due largely to a lack of appreciation of their value for the purposes for which they are intended. Little difficulty has been experienced by the commission in persuading the private utilities to keep such records properly, but some of the municipalities have been hard to convince. Several years ago one city in Wisconsin, having a population of about 17,000 people, took over its water plant from a private concern as permitted under the provisions of the public utilities law. The commission has ever since been trying to induce the city to keep accurate operating records as well as construction costs. Recently a complaint on rates was made against the city; the engineers visited the place to obtain records of construction and cost and found the book-keeping in very poor condition. All items of expense of the city, including water works construction, operation, etc., were on consecutively numbered vouchers. In order to determine what had been spent for construction and operation of the water plant it was necessary for the engineer to look through every voucher passed by the city in the years since the plant was taken over. The cities do not appear to comprehend the fact that accurate records of the financial transactions of the utility are necessary as a basis for the determination of equitable rate schedules.

If, however, it be conceded that consumers are receiving equitable treatment only when the schedules are so constructed that each is required to meet as nearly as possible his proper share of the expenses of the utility, then the necessity for keeping accurate operating records is proved, for in no other way can these results be obtained. Several instances have occurred in Wisconsin in which the railroad commission has found it impossible to make rulings on account of lack of operating records, and it has been found necessary to postpone the decisions until at least one year's records could be obtained.

Quoting from the decision of the commission in the case of the Troy and Honey Creek Telephone Company for authority to increase rates, W. R. C. R., Volume 6, page 555:

Until the utility keeps the cost of renewals, replacements, and new construction separate from operating expenses, it will be impossible to determine the exact needs of the company in the way of revenue. . . . It is quite possible that the application therein is reasonable and that it should be granted. Just what the real situation is in this respect, however, we have not been able to fully determine, owing to the condition of the records and the reports of the business of the plant that have been submitted to us. If the

petitioner will comply with the Utilities Law and keep its records as provided therein, or so as to disclose the condition of its business. . . . this Commission will be ready to reopen this case and to endeavor to the best of its ability to reach a fair and equitable decision therein. Until these steps have been taken by the petitioner, we are not in a position to safely pass upon the issues involved, and the proceedings in this matter are therefore, for the present, dismissed.

There have also been before the commission many other cases of a similar nature which it was found impossible to handle in a satisfactory manner because of lack of proper operating statistics. This question of proper operating data is in a sense independent of the question of state control, but without some centralized regulating body requiring these reports there is very little reason to think that either municipal or private utilities will keep records in such form as to be of use for these purposes.

The reports received by the Railroad Commission of Wisconsin from various utilities for the year ending June 30, 1914, have been divided into three classes: good reports, fair reports, and poor reports. These are tabulated below for electric plants and for water plants, separating between private and municipally owned properties and further separating as between the various classes of utility according to the size of the city served.

Number of electric plants in Wisconsin making good, fair and poor reports to the railroad commission on June 30, 1914

CLASS	PRIVATE				MUNICIPAL			
	G	F	P	Total	G	F	P	Total
A.....	20	6	4	30	*			
B.....	19	16	5	40	5	3	9	17
C.....	12	9	3	24	5	5	2	12
D.....	22	14	7	43	8	7	10	25
Condensed	19	26	14	59	3	10	5	18
Total.....	92	71	33	196	21	25	26	72
Per cent.....	47	36	17	100	29	35	36	100

*At this time there were no class A municipal electric plants in Wisconsin.

Number of water plants in Wisconsin making good, fair and poor reports to the railroad commission of June 20, 1914

CLASS	PRIVATE				MUNICIPAL			
	G	F	P	Total	G	F	P	Total
A.....	7	1	1	9	5	6	2	13
B.....	3	1	4	8	8	9	20	37
C.....	2	0	0	2	8	8	8	24
D.....	1	1	1	3	7	22	22	51
Condensed	2	1	1	4	15	14	9	38
Total.....	15	4	7	26	43	59	61	163
Per cent.....	58	15	27	100	27	36	37	100

In general, this information may be summed up as follows: of the 196 electric plants privately owned 47 per cent made good reports, 36 per cent made fair reports, and 17 per cent made poor reports. Of the 72 electric plants municipally owned 29 per cent made good reports, 35 per cent made fair reports, and 36 per cent made poor reports. Of the 26 water plants privately owned 58 per cent made good reports, 15 per cent made fair reports, and 27 per cent made poor reports. Of the 163 water plants municipally owned 27 per cent made good reports, 36 per cent made fair reports, and 37 per cent made poor reports.

The tables given below show the financial data with respect to the municipal plants both electric and water which make the reports referred to in the above table.

Summary of financial data of municipal electric utilities in fourth class cities and villages June 30, 1914*

	PROPERTY AND PLANT	OPERATING REVENUES	OPERATING EXPENSES**
Good reports.....	\$679,793	\$225,295	\$150,637
Fair reports.....	548,362	182,456	129,934
Poor reports.....	416,999	154,830	106,284
Total.....	\$1,645,154	\$562,581	\$286,853

* 10 utilities are omitted because of incomplete reports or unavailable data.

** Excluding interest, depreciation and taxes.

Summary of financial data of municipal water utilities in fourth class cities and villages June 30, 1914*

	PROPERTY AND PLANT	OPERATING REVENUES	OPERATING EXPENSES
Good reports.....	\$1,354,879	\$147,881	\$86,319
Fair reports.....	2,109,048	238,797	158,062
Poor reports.....	1,481,500	172,495	104,584
Total.....	\$4,945,427	\$559,173	\$348,965

* 25 cities are omitted because of incomplete reports or unavailable data.

Summary of financial data of municipal water utilities in cities of 10,000 population or over June 30, 1914

	PROPERTY AND PLANT	OPERATING REVENUES	OPERATING EXPENSES*
**Good reports.....	\$9,652,303	\$1,171,884	\$357,367
Fair reports.....	2,342,542	202,969	90,764
Poor reports.....	726,931	96,570	41,261
Total.....	\$12,721,776	\$1,471,423	\$489,392

* Excludes interest, depreciation and taxes.

** Includes Milwaukee, the values for which are more than three-fourths of the total.

From the above tables the following facts may be gleaned: for the municipal electric utilities making these reports 60 per cent of the operating revenues are in plants from which unsatisfactory reports are received.

In the municipal water utilities in fourth class cities and villages 74 per cent of operating revenues are in plants from which unsatisfactory reports are received; and in the municipal water utilities in cities of 10,000 population and over, 21 per cent of operating expenses are in plants from which unsatisfactory reports are received. This latter per cent would be considerably higher were it not for the fact that the city of Milwaukee makes a good report and its values are some two-thirds of the total values in the entire group.

Since both fair and poor reports indicate a lack of knowledge of what is really being accomplished in operating matters, a further summary would be as follows: in the privately owned electric plants in Wisconsin 53 per cent of the reports were unsatisfactory; in the municipal electric plants 71 per cent were unsatisfactory; in the privately owned water plants 42 per cent were unsatisfactory and in the municipal water plants 73 per cent were unsatisfactory.

In spite of the unsatisfactory condition of the reports received there is shown a great advance over the records kept before the commission prescribed definite forms of accounts. Recently the commission's accounting department has been giving a great deal of assistance to municipalities as well as private owners of utilities for the purpose of starting them out on a proper accounting basis. It is found that when not required to do so by the commission, municipal utilities seldom keep records in proper shape for adjustment of rates. Construction costs are confused with operating expenses; in many cases no distinction is made between repairs and replacements. Many times the records of the utilities are not separated from those of the general business of the city as was illustrated in the case above cited. Not only is it impossible from such records to make a fair determination of the cost of the different classes of service, but even the total cost of the service cannot be obtained. Such records must be kept properly whether rates are to be controlled by the central commission or by the municipality itself.

It is readily conceivable that a schedule of rates may be free from discrimination as to individual consumers, as well as to classes of consumers and the total profits may not be excessive, but still the consumers as a whole may be paying more than they properly ought to pay, because of inefficient operation of the plant. The question in this form applies as much to municipal plants as to privately owned plants. It is important to know that operation is efficient, and in order to determine this question it is necessary to have records of plants other than the particular one under consideration. With a system of local municipal control there is but one method of obtaining this information. Each municipal utility will be put to the expense of making such an investigation of the records of other plants as may be required to determine this matter. This investigation will necessarily have to be made by some person properly equipped to make such a study and few, if any, of the smaller municipal utilities can afford such an investigation. Even the possibility of such an investigation presupposes that the individual plant records will be properly kept, which past experience shows is not the case. Furthermore, even though the individual utilities may keep their records in such form as to determine this matter of proper expense in a satisfactory manner, still, unless there is distinct uniformity in the accounting methods, it will be difficult to make the necessary comparisons. Under supervision of the Railroad Commission of Wisconsin

this question of uniform accounting is insisted upon and is being obtained.

In order to illustrate another important use to be made of operating statistics there is given the following table showing the total operating expenses in dollars per million gallons pumped for Class A municipal water utilities, taken from the annual reports for the fiscal year ending June 30, 1912:

Municipal water utilities—class A

Detailed and total operating expenses in dollars per million gallons pumped for year ending June 30, 1912

LOCATION OF COMPANY	MILLION GALLONS PUMPED	TOTAL PUMPING	TOTAL DISTRIBUTION	TOTAL COMMERCIAL	TOTAL GENERAL	TOTAL UNDIS-TRIBUTED	TOTAL OPERATING EXPENSES
Appleton.....	513	\$16.58	\$2.85	\$0.62	\$1.75	\$0.75	\$22.15
Eau Claire.....	730	7.80	5.18	2.12	1.31	0.55	16.96
Kenosha.....	1,161	11.50	3.89	1.21	1.23	0.17	18.00
La Crosse.....	1,025	15.91	5.05	0.39	0.84	0.34	22.53
Madison.....	688	38.21	6.86	4.50	2.14	0.61	52.32
Manitowoc.....	332	19.51	5.90	0.38	1.88	0.77	28.44
Milwaukee.....	17,024	6.69	3.66	3.32	1.34	0.90	15.91
Sheboygan.....	1,121	11.52	2.62	0.33	2.54	1.17	18.18
Watertown.....	304	25.25	6.99	2.23	4.35	0.86	37.45
Waukesha.....	264	54.59	27.47	0.33	7.38		91.67
Wausau.....	841	12.64	2.07		1.18	0.38	16.60
Average.....	1,495	20.94	5.53	1.85	6.05	0.89	35.32

The above table shows the total cost per million gallons pumped as well as the various items which compose this total, such as cost of pumping, distribution, etc. This has been determined upon a uniform basis and shows the particular plants which are operating at a cost far above the average. In one case the total cost per million gallons pumped is \$91.67 and in another \$52.32. The normal cost exclusive of these two plants is approximately \$25 per million gallons pumped. These figures are of course not conclusive evidence that the two plants mentioned are being inefficiently operated, but it opens a line for careful investigation of these plants. Add to the above a definite knowledge of local conditions surrounding each situation and it is then possible to make a proper decision in each case. Such methods of keeping records permit an investigation not only of the

total actual cost but of each particular item of cost, which thus permits the matter to be attacked in the necessary detail. In the accounting required by the commission the accounts are still further subdivided in order to assist in detecting the various items which go to make up the particular cost in each class.

In a recent investigation by the commission with respect to the rate in a gas plant, the accounting showed that, by comparison with results obtained with other plants, this utility was producing some 10 per cent less gas per pound of coal than the normal and that the losses in distribution were almost twice the normal. It was also found that the maintenance expenses were some six cents *more* per thousand cubic foot of sales than the normal as shown by other plants. These facts were taken up with the utility management who admitted the inefficiency and acknowledged that these matters should be taken into account in the fixing of rates.

In another case in which water rates were under investigation comparisons with other utilities showed that the cost of fuel used for pumping was considerably above normal. In that way it was determined that a reduction of about 40 per cent should be made. As a result this reduction was actually made in computing rates. Since that time the expenses for fuel in the operation of this plant have been within 5 per cent of the amount determined upon by the commission.

These illustrations of course are applicable to municipal as well as to privately owned utilities and are cited for the purpose of emphasizing the necessity of accurate accounting methods.

The commission has had before it many cases involving rates and service of municipal plants. An investigation of the various reports and files of the commission shows that these complaints are on a variety of subjects, such for instance as the following: excessive and unwarranted water rates, inadequate commercial service, unsatisfactory water resulting from failure to flush out mains, sand and dirt in the mains, unsanitary supply, inadequate supply, lack of pressure for fire protection, entire discontinuance of service, discrimination between metered and flat rate customers, unjustifiable rates, application for increases in rates, application for equalization of rates, application for adjustment of individual rates, installation of meters and proper manner of paying for same, refusal to permit use of certain types of meters, inequitable distribution of rates, refusal to furnish electric and water rates, refusal to extend water mains and electric wires, classification of certain services, complaint against

council for changes in rates, excessive charges due to leakages, application for valuation for municipal purchase.

This list of types of complaint shows the great variety of subjects which the commission is required to deal with in connection with municipal plants, where the question of total profits is not an issue. In view of this, where is the individual consumer to find redress if there is no central disinterested body in control? If redress were possible with local control, why should not these matters have received the necessary consideration without compelling the individual to go to the commission for satisfaction? Is it likely that the local authorities will be more anxious to satisfy the complainant if there is no opportunity for him to appeal than when it is a known fact that he can lay his case before the higher authority?

Even when municipalities undertake the making of schedules with the best of intentions they are in general not in any position, because of lack of ability or finances, to attack the problem in a proper manner, and, when their actions are controlled or affected by political issues, the question of equitable rates is too often subordinated to political demands. In many cases the operation of the plants is used to furnish capital for city politics and under such circumstances it is difficult to conceive of fair rate schedules being put into effect by municipalities when the matter is not controlled by a central body. Experience in Wisconsin before the utilities law became effective, which is probably duplicated in all other states, has been that in many cities and villages under municipal control some individuals are actually given water, gas, or electric service for years without contributing one cent and often without even a record that a service connection had been made. The other consumers are necessarily called upon to pay increased bills resulting from such discrimination.

In general each utility, whether municipal or privately owned, is supplying two distinct types of service. First, public service such as protection against fire, street lighting, water and lighting for public buildings, etc. Second, service to private consumers such as general lighting, power and water service. In other words, the two distinct types of service are, first, those for which payment should be made by taxpayers through the medium of the city taxing department, and second, those for which each private consumer should pay his fair share direct to the department. In all investigations relative to rates the first consideration should be a fair division between the

property used for public purposes and that used for supplying private consumers. The engineers of the Railroad Commission of Wisconsin have made very careful separations of these values in all instances, and the accounts are required to be kept in such manner that operating expenses may likewise be divided between these two principal accounts. It is often a difficult matter to induce municipalities to permit the water and light department to render bills against the city for the proper amounts to cover the share of the expenses which are properly chargeable to the taxpayers, and it is more difficult still to secure the actual payment of these amounts, yet for every dollar thus retained the consumers have to pay a corresponding amount in addition to the cost of their own service, which amount should in justice have been paid by the taxpayers. Taxes are unpopular and unless compelled to do otherwise there is a strong tendency on the part of municipal authorities to keep taxes down at the expense of the private consumers.

Schedules submitted by municipal plants for approval by the railroad commission often show the following inequalities: in some the city pays nothing for service and the general users bear all of this cost. This results in discrimination in favor of taxpayers. In some cases the city pays a part of the cost of public service but not a sufficient amount. This again results in discrimination in favor of the taxpayers. This condition exists where hydrant rental or street lighting allowances are too low or where no charge is made against the city for lighting and water service to schools and other public buildings. In some cases the rates for general service are so low that they do not cover the fair share which the consumers should bear, the remainder being made up by taxation. This results in discrimination in favor of the consumers and against the taxpayers. These points emphasize the necessity of a careful study of the two phases of the problem in order that each may receive just consideration and discrimination be avoided.

As a further illustration of the above remarks we find in one of the commission's decisions relating to a municipal electric light and water plant the following:

The investigation has shown that while the electric department is self-sustaining the water department has failed to earn a sufficient revenue to meet its legitimate expenses. . . . That while a reduction in rates for electric service can be offered, the rates should be adjusted so as to more equitably distribute the burden of expenses; that the charge for street lighting should

be increased in order that this branch of the service bear its just share of the total cost of operation; that the water rates should be adjusted so as to better meet the conditions now existing and which in the near future will exist. That the city should bear a larger burden of expenses due to the larger proportion of the system made necessary for fire protection and other public uses. W. R. C. R., vol. 5, p. 5.

After having made a proper division between expenses chargeable against the public and those chargeable against the private consumer, then further subdivisions are needed to determine the fair division of cost between different classes of consumers, such as users of electric light as compared with those using electric power; users of water for domestic purposes only as compared with those using water for commercial and industrial purposes. Often these consumers are placed either on a flat rate or a uniform meter rate with the result that there are usually discriminations affecting the different interests.

One of the difficult features which must receive consideration whether the rate schedules are being prepared by local management or by a central body has not yet been touched upon. An electric plant must be of such capacity that it can at any time and upon a moment's notice be called upon to supply the maximum demand which may be put upon it. In this it differs from a gas plant or a water works plant in both of which the product can be stored. Electrical energy can be stored only to a very limited extent and even such storage requires expensive equipment. The question of fair rates between consumers, some of which use this electric power only during peak periods, others of which use it only during off-peak periods, and others which use it during all periods of the day, is one with which the average plant operator is unable to cope and unless schedules are made or supervised by trained and experienced authority, discriminations are certain to result due to the above mentioned causes. Furthermore, each particular case is a problem in itself and though the same principle may be applied to all, each must receive separate consideration.

It is often easy for a plant operator to discover various discriminations, but in general it is beyond the ability of the average manager or local commission to so construct a schedule that these will be eliminated. This inability is emphasized in many cases brought before the commission. The following is quoted from some recent decisions of the commission, as samples of a great many such cases brought up for adjustment:

In Re Application of the Cumberland Municipal Electric Light Plant for Authority to Increase Rates. "The applicant in this case desired to increase certain of its present rates for electric current, on the ground that these rates were inadequate and did not cover the cost of furnishing the service involved. Upon hearing and investigation it was found that the applicant's rate schedule was not properly adjusted and that certain classes of consumers paid less than their just share of the cost of operating the plant. Because of these facts the Commission endeavored to compute more equitable schedules of rates, and has authorized the applicant to put these rates into effect." 4 W. R. C. R. 214.

In Re Application of Stoughton Municipal Electric Light System for Authority to Increase Rates. "The applicant in this case stated in its petition that it desired to make such changes in its rate schedules as to enable it to more fully extend its business. At the hearing in this matter it was shown that the present schedules were not, on the whole, so adjusted as to meet local requirements. These facts were substantiated by the further investigation into the situation which was made by this Commission. For these reasons the applicant was authorized to readjust its rate schedules on the basis outlined in the order in this case." 3 W. R. C. R. 484.

The authorities are coming more and more to realize the necessity for scientific investigation of methods of rate making with respect to the cost of service principle and many cases are being laid before the railroad commission for determination. The following quotations are samples of the many cases of this nature being voluntarily brought before the commission by the city and village officers themselves.

Board of Water Commissioners of Fond du Lac. the Railroad Commission has been called upon to recommend not only rates for service, but also to recommend an entire set of rules and regulations governing the relations between the plant and its consumers.

Baraboo City Water Works. This is a request made by the water works commission of the city of Baraboo that the Railroad Commission investigate the financial and operating condition of the Baraboo Municipal Water Works Plant and recommend a fair and equitable apportionment of the total expenses of said plant between the *public or city* and *private or domestic* consumers, and also to make such further recommendations as regards the *rate schedule* in general as may appear just and reasonable in view of the conditions.

Evansville Municipal Electric Light Plant. "This matter is an investigation on motion of the Commission of the rates, rules and regulations of the municipal electric and water utilities of Evansville, Wisconsin. The investigation arises from a series of requests from the city's officials for assistance in revising and adjusting the rates and practices of its utilities."

Following is a list giving some of the lines in which the Railroad Commission of Wisconsin is voluntarily assisting municipalities with a view of improving standards of service, and insuring equitable rates:

Establishment of proper accounting procedure, calculation of proper rate schedules, proper methods of recording meter test records, calibration of necessary testing apparatus, assistance in regulation of voltage and other features of the service, assistance in drawing contracts for construction of electrical and water plants, assistance in determining upon satisfactory water supply, investigation of water power sites for municipal plants, valuation of property for purposes of accounting, valuation of property for municipal purchase, many other consulting engineering matters on a variety of subjects connected with the construction and operation of water, gas and electric properties.

During the first few years of the operation of the public utilities law in Wisconsin the various utilities found difficulty in complying with the uniform accounting system required by the railroad commission. Small utilities were unable to pay the amounts demanded by private accountants for doing the work and these accountants did not always adhere strictly to the commission's classification. As this latter is an essential feature for the purpose of rate making, the commission adopted the system of supplying accounting assistance to utilities. This is done by the commission's own accountants and the utilities are required only to pay the actual cost thereon. Many municipalities are taking advantage of this opportunity and the commission is installing accounting systems as rapidly as its accountants can carry out the work.

No doubt one of the best means within reach of operators for keeping themselves informed in the utility business is to become identified with national associations organized for the promotion of the interests of those connected with utility business.

In order to obtain an idea as to what extent those interested in plant operation, especially those connected with municipal plants, are availing themselves of such opportunities to familiarize themselves with latest practices, search was made of the 1914 membership list of the American Water Works Association for the names of persons identified with various plants, municipal and private, in Wisconsin. The results of this investigation show that of the 26 privately owned water plants in Wisconsin 6 are represented in the active membership and none in the corporate membership. Of the 163 municipal water plants in Wisconsin 9 are represented in the active membership and one in the corporate membership.

A similar investigation of the membership of the New England

Water Works Association reveals the fact that of the six members residing in Wisconsin, one represents a private plant, and none represent municipal plants.

The membership list of the Wisconsin Electrical Association shows 5 individual members and 4 company or commission members representing the 72 or more municipal electric plants in the state.

The exceedingly small number of members of the two national water works associations representing municipal plants in Wisconsin, being only 9 for the 163 plants, and the correspondingly small number belonging to the electrical association indicate that municipal officers are very slow in taking advantage of the means readily at hand for keeping themselves informed upon important matters over which they have control and for which they should feel a deep concern.

No doubt the short tenure of office which is so general in municipal affairs is largely responsible for this condition. But whatever the reason, it is a fact that has a decided bearing upon regulation of utilities by local boards. It is very probable that this short tenure of office is one reason for inefficiency in municipal plant operation. All too often a change in the personnel of the city officers means a change in the management of the plants. Again, each administration is loath to assume the responsibility of burdening the city or village with new machinery or equipment, the result being that obsolete or inadequate types are very often retained in municipal plants long after their usefulness is gone, a fact that would be recognized and remedied much earlier in a privately owned plant.

These remarks are not intended as arguments against the municipal ownership of public utilities. They are intended to point out the fundamental difficulties certain to be encountered by municipalities in attempting to obtain high standards of service and fair rate schedules for their own utilities. In very few instances are the municipalities financially able to employ the necessary expert advice to build up proper schedules or recommend proper standards of service. Furthermore, without uniform accounting systems, what basis could even an expert employ? It is certain that uniform accounting systems will not be installed unless a central board or commission prescribes such systems and has authority to see that the accounts are properly kept.

A state commission, by the employment of a very few experts, can be in position to install and supervise proper accounting methods

at almost negligible cost to the hundreds of utilities in the state. By means of their experience and training, supplemented by the statistics thus obtained, these experts are in position to recommend advisedly on the subjects of proper rates. Engineer inspectors who visit all plants and study methods of operation under all varying conditions with respect to economy and efficiency are surely better able to advise with respect to standards of service and operating economies than are local boards or managers who seldom if ever observe conditions outside of their own neighborhoods, and whose terms of office are often so limited that they are no more than partially acquainted with their own local problems than new officers supplant them, who in turn have the same problems to master. Under such circumstances it is no reflection upon these local boards and managers to say that the problems are quite beyond them. The conditions are not within their control. But here stands an ever ready agency supplied by the state and prepared to give just such advice and assistance as are necessary to permit these managers to meet their problems in an efficient and inexpensive manner. Why should they not avail themselves of it? One of the very disheartening features of our experience in trying to maintain high standards of service, especially in the electrical field in Wisconsin, is the distinct deterioration often noticeable at once upon a change of management. After years of patient labor building up a municipal plant to the point where conditions are satisfactory, the inspector returns after a few months absence to find a new man in charge who is entirely ignorant of all that has gone before. A large part of the work has to be done over again in the same painstaking manner. The effect of these lapses is discouraging, but they serve to emphasize most emphatically the great advantage of having at hand means of placing the service again on its high plane, and are sharp reminders of what might be expected of the future of the service if no such authority existed.

There appears to be a well established conviction that a central commission is needed to regulate service and rates of private utilities. Conceding this, and in view of what has been shown above, is this not itself a strong argument for regulation of municipal properties also by a centralized body?

There is no doubt that the service standards and accounting methods prescribed and insisted upon by the railroad commission throw a burden upon municipal plant operators that could be avoided to a large extent if these managers were left to their own devices,

but the fact should always be borne in mind that these standards and methods are installed primarily for the benefit of the consumers.

Village and city boards and councils are in position to make their protests heard and felt through legislation, but it is the writer's firm belief that if the consumers who are the principal owners of municipal plants and the ones who benefit most by proper rate and service regulation had a thorough understanding of the benefits to be derived from state regulation and could balance these considerations against all the disadvantages, they would almost unanimously demand state regulation with its relief from inefficient and often indifferent control by local boards or commissions.

SOME ECONOMIC ASPECTS OF WATER WORKS VALUATION

BY RALPH E. HEILMAN¹

The valuation of utility properties for rate making purposes has become an important problem in recent years. It will no doubt soon prove to be an important problem for all the privately owned water plants in Illinois, for the recent act creating the Public Utilities Commission places all such properties under the control of that commission. This act apparently gives to the commission the power to regulate, change or re-adjust the water rates at any time it may choose to do so in spite of the fact that many water companies are operating under franchises previously granted by municipalities, which give the right to make a certain charge until the expiration of the franchise period. This act apparently repeals and annuls all such outstanding franchises, and so the commission holds. Therefore, the question of valuation becomes of importance since the commission, in the opinion of the courts, must rest its rates upon the value of the property.

Valuation of water works is largely an engineering problem. Nevertheless, there are some very important aspects which present themselves concerning which the economist feels that he has something to say. There are several such economic questions, as for example, the allowance to be made in the valuation for franchise, good will, going concern, developmental expense and early losses. In the limited time at his disposal the writer will be able to discuss only one, namely, the proper allowance for developmental expenses and early losses.

A water works plant, like other businesses, often does not do a paying business during the first few years of operation. Business must be built up, individuals must be impressed with the superiority of the service over the use of wells, patronage must become established before the company really begins to earn a profit or fair return. Should not the expenditures thus incurred be included in

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the valuation of the plant for rate making? If the corporations are to receive a return which would be only sufficient to attract capital under present conditions, what is to be done regarding the deficit or dearth of adequate returns during the early years of the company's history? Are these not a part of the investment necessary to establish the business?

Four methods of dealing with this problem in utility rate cases have been adopted. (1) Refusal to allow anything for this purpose. Both the Nevada and Nebraska commissions have taken this position. This position is essentially unsound. It is evident that unless such losses are in some way made up to the companies, private capital for utility enterprises will not continue to be forthcoming. (2) The Wisconsin method, which is to add early deficits and developmental losses to the valuation of the plant. Such losses, therefore, become assets, upon which the consumers are to pay a return permanently. (3) The New York First District commission's plan, which is to permit the company to charge in later years a rate sufficient to offset the deficiencies below a fair rate in the early years. (4) The New Jersey method, which is to add all expenditures to develop patronage to the valuation of the property.

The Wisconsin commission says, in justification of its method:¹ "These early losses . . . represent the cost of the business in very much the same way as that in which the cost of construction represents the cost of the physical plant. One appears to be as legitimate and necessary a part of the cost of the enterprise as the other." The commission qualifies the application of this principle by recognizing that early deficits can be thus treated only when the conditions under which they were incurred are proper ones.² "When such deficits are due to abnormal conditions, or are due to bad management, defective judgment, extravagance, lack of ordinary care or foresight, unduly high capital charges, and other causes of this nature, it is manifestly clear that they should be accorded little or no consideration, in either the valuation or the rates."

The St. Louis commission which proved itself probably the most efficient municipal commission in the country also adopted this principle, and in its valuation of the property of the Union Electric Light and Power Company allowed \$1,000,000 for this purpose, saying: "These initial losses . . . are in fact a part of the

¹ Wisconsin Railroad Commission Reports, Vol. III, p. 624.

² Wisconsin Railroad Reports, Vol. IV, p. 585.

legitimate investment, and should be permitted into the earning value as a part of the investment."³ The California commission approves of the doctrine that early losses should be recouped to the companies in some way, saying: "That there are certain actual costs incurred in developing the business during its early stages, for which costs the utility is entitled to be reimbursed . . . seems too obvious for argument." This principle and method have also been adopted by the Georgia, New Hampshire and Ohio commissions.

The objection of the New York First District commission to this plan appears to be that thereby any close relation between the valuation used for rate making and the actual physical value of the plant may be destroyed. The commission holds that "the amount included for going concern should be limited to expenditures made prior to the time when operation begins," and that after that, the various expenses which go to make up "going concern" should be charged to operation.⁴ If the policy results in losses in the early years, the company should be permitted in later years to charge rates sufficient to offset its deficiencies below a fair return in the early years. The commission states that to include such losses in the valuation of the property, or to permit them to be capitalized "is absurd, leading to gross over-capitalization." The Maryland commission has followed the New York practice, and in some cases where early losses actually occurred it has increased the rates in order gradually to provide for and cover such losses. But in no case has it permitted the inclusion of such losses in the plant valuation.

The Wisconsin practice seems to be the more rational. If the early deficits incurred in order to build up the business represent the cost of the property in the same sense that the investments in material equipment do, that is, if they are equally necessary, then the natural procedure is to add the amount of such deficits to the investment in equipment, the whole to represent the total investment upon which the company is entitled to a return. It is true that to do so means that a return upon these early deficits will be saddled permanently upon the consumers. But if such deficits, assuming them to represent wise expenditure, are a part of the legitimate and

³ Report of the St. Louis Public Service Commission on Rate for Light and Power, 1911, p. 54.

⁴ Queens Borough Gas & Electric Company case, decided June 23, 1911, No. 2, P. S. C., Report 1st District, New York.

necessary investment in the property, this is certainly proper. It may be immaterial to the company which method is used, since by either method it is, in reality, compensated. But to the consumers it may be a matter of importance, for the New York method brings a discrimination against the present consumers as compared with future ones. Why should the consumers of today be burdened with a higher charge for the purpose of recouping to the company one part of its investment—early losses—any more than they should be burdened with a higher rate to recoup the value of its land or buildings, in order that the consumers of tomorrow may not be required to pay a return upon such part of the investment?

Both the Wisconsin and the New York First District plans contemplate that only the deficits incurred in developing the business shall be made up in some way to the company. The fourth method as applied by the New Jersey commission applies an entirely different mode of reasoning. This commission holds not only that early deficits should be added to physical value, but that expenditures to get patronage and to develop the business should be included in the valuation, whether or no such expenditures have ever been recouped to the company. This theory is announced in its boldest form in the Public Service Gas case⁵ decided December 26, 1912. In this case the commission announced that it would add about thirty per cent to structural value for "going value," such value to be "largely represented by the cost of developing the business, as distinct from the cost of securing the physical structure." The commission held, "we see no escape from the necessity of recognizing the intangible property designated as 'going concern value,' as well as actual physical structures similarly obtained, as constituting part of the present lawful possessions of a public utility, even though both the tangible and the intangible values were built up in the past, out of rates exacted from the consumers. . . . If these high rates in the past have been employed by the company to acquire intangible property in the shape of extensive patronage, that expectation of patronage is theirs, and on its fair value the company is entitled to a return. The 'going concern value' will then be largely represented by the cost of developing the business as distinct from the cost of securing the physical structure." The principle laid down is that this cost of "developing the business"

⁵ Report of the New Jersey Board of Public Utility Commissioners for 1912, p. 246.

should be added to the value of the physical property, even though expenditures for this purpose never produced a deficit, or a lack of adequate returns; in fact, quite regardless of what the returns of the company in the past may have been. "The going concern value may include the cost of soliciting business, cost of advertising, cost of inducing consumers to take service, cost of exhibiting appliances, cost of occasional free installations, etc." In other words, all such expenditures in the past are to be charged to capital account, even though these expenditures did not intrench upon a fair return. And this is because, "a plant with a business attached has a value greater than the value of the mere plant without the business attached."

This scheme calls for the most severe condemnation. It represents in the purest form, the capitalization, not simply of losses or deficiencies below a fair return, but of expenses. If all expenditures incurred by a company in order to secure and establish its business are to be added to capital value, then practically all expenses must be so treated, for practically every expense is incurred either to get or to hold business. All expenses of doing business are surely expenses incurred in order to hold the patronage, and are therefore responsible for the fact that the plant has a "business attached." The amounts expended for fuel with which to manufacture gas, the salaries of officials, the wages of employes, the cost of materials used, and all other legitimate operating expenses have been incurred either to develop or to hold patronage, and therefore, to "establish a plant with a business attached." For it is evident that if these expenditures were not made, there could not long be any patronage. It is obvious that to charge all operating expenses to capital would be unthinkable. But no differentiation can be made between the cost of getting patronage and the cost of serving the patronage, since without the service the patronage would not continue. Both are, properly, operating expenses.

The error of the New Jersey commission is due to its unqualified acceptance of the premise "a plant with a business attached has a value greater than the value of the mere plant without the business attached." This is always true in private business, but in the regulation of public utilities it may or may not be true. If a value in addition to physical value is to be allowed because there is a patronage established, it is evident that the cost added must be not the gross cost but the net loss, i.e., the deficits or the lack of adequate

returns due to developmental expenses. For it is only this amount which measures the *bona fide* investment, the sacrifice made by the owners of the property, in order to build up its business. To add the total expenditures made to develop the business regardless of the earnings which have been made means that all other operating costs incurred in the past, whether reimbursed to the company or not, should likewise be added to plant value: a preposterous proposal.

QUESTION BOX

1. Experience in the use of caps instead of plugs on dead ends and unconnected branch pipes; is there any economy or advantage in the use of such caps?

SECRETARY DIVEN: The secretary propounded that question. In going to a new city he found that instead of using plugs in branches, a short piece of pipe had been put on and capped. The speaker could not see the economy of that arrangement, and asked what the reason was. He was told that it was done because it was easier to take off. He believed that, because he had not been in that new location six months before six of them blew off of their own accord. The speaker had been in the water works business for about forty years and had never used that sort of an arrangement and was wondering why they were used and wondered if anybody else had used them.

2. What legal right has a water company to the use of public streets after the expiration of its franchise? Experiences of water companies whose franchises have expired, especially in cases where duplicate public works have been built.

MR. J. N. CHESTER: That depends upon the location, state or city in which you are and what the nature of the franchise rights is.

SECRETARY DIVEN: The question was asked whether they would have to stop doing business after the expiration of their franchise—if they would have any right to dig up the streets after the franchise had expired?

MR. J. N. CHESTER: In some states the courts have said they may, and in some others they have said they may not. There have been as many different decisions as there are states.

MR. GEORGE HOUSTON: The speaker did not ask that question, although he was glad to see it in the list, being particularly inter-

ested on behalf of his city where the franchise of the gas company is about to expire, and a great many of the people have the idea that all they have to do at the expiration of the franchise is to say, "Come on, boys, we will go down and take possession." We would really like to know where we are at; and if anybody knows a case that has been tried out on that line would appreciate the information.

MR. H. C. HODGKINS: There is not much doubt about where such a company is at; it is pretty nearly in court in a law-suit. It formerly would have had to go into a court of equity to acquire additional rights; and the way the question is stated the speaker does not think it had any standing whatever. The establishment of public service commissions in various states has in great measure superseded franchises and nullified a great many decisions, so that a great deal of the information contained in past decisions is of little value.

Wherever you have an indeterminate permit act, naturally any decisions prior to that are not applicable. If the state in which the franchise is located has a public service act that act should certainly define the rights under such franchise and after the expiration of the franchise; and if it does not then the old law prevails. So references to other states will hardly be valuable.

MR. F. J. CONNOR: The Sioux Falls case was a noted one, and the court in deciding it said, "This company goes out of the water works business on a certain date," and after saying that he gave the company the right for a year after the expiration of the franchise to have the pipes removed. The company removed about twenty miles of mains of sizes from 4-inch up to 16-inch and dismantled the entire plant. Of course, we had two systems for about a year. At the speaker's first installation as superintendent we had what was called the "old company" and the "new company." They were both doing business, and one was taking the consumers away from the other.

The speaker wants to say frankly and fairly, if any of you are fighting with a company, for the good of your community, if the old company has a good lawyer and is willing to spend lots of money, the lawyer will probably milk them, and the case will work out about like it did in the case of the Irishman who went to one lawyer and said, "I have a little trouble with my brother, and I

want to start a suit against him." The lawyer said, "I have your brother's case, but I have a good friend down the street, you go to him, and I will give you a letter of introduction." So he wrote a note and gave it to Mike to take to the other lawyer. Mike was a little curious, and he opened up the note and read it. It went this way: "You look after one, and I will look after the other." So that will be about the way with you that are fighting the company, and while the speaker has charge of a municipal plant, his best advice to you is, if there is any possible way to settle the thing, lay aside personal grievances and do not get into litigation; try to settle it in some way, and you will all come out better.

MR. J. M. DIVEN: It seems as if the last speaker left out part of that story; that there was an addition to that note to the effect that by and by the lawyers would have the property.

MR. E. E. DAVIS: We have never had much trouble about franchises but we sometimes have questions in dispute that come up for settlement that would keep half a dozen lawyers busy. The lawyers of Richmond are very kind to the speaker, who frequently makes decisions for them, and they abide by them. Some time ago a question came up in regard to a line of pipe that was laid to an annexed territory. The work was done under the supervision of the water works department under certain specifications as to sizes, etc., and disputes came up, and under the agreement any such dispute was to be handled by three disinterested parties, who probably would have been lawyers. But instead of getting three disinterested parties we handled the matter through the administrative board very satisfactorily to all concerned.

MR. W. A. PATTON: The speaker is responsible for this question, at least he submitted it to the secretary at last year's convention, and was disappointed afterwards in not being able to attend. He did not know that it had been carried over to this meeting.

The question is worthy of some investigation. Private water companies who have immense investments at stake are entitled to rights as well as municipalities. This question is well worth consideration because it affects vitally those who have their money invested in private water works. In the city of Cincinnati recently a case came up, the speaker cannot give you the exact style of the

case, but thinks it was a case where a company attempted to carry some pipe across the street to a neighbor, and it was decided by the lower court, and the party gained his point. The decision in effect was that he was a tax-payer and abutting property owner and had the same right to the streets as any one else; on the principle that the streets are public property, and as long as his pipes do not interfere with the general use of the street, as a tax-payer he has that right. Now that is a question that is well worth considering; and if this question cannot be answered at the present time trust that those who can give information relative to it will have it in readiness for the next meeting.

MR. W. F. WILCOX: The only decision that the speaker knows of bearing on the question is a decision in the case of the town of Canton, Mississippi vs. the Illinois Central Railroad, in which the Supreme Court of Mississippi decided that it was not within the purview of the railroad to use a street, because it was a railroad corporation and they will not allow a railroad company to use streets for the purpose of laying a water pipe.

3. What experience have you had in the use of lead wool for joints in cast iron pipe? Is it as economical and satisfactory as melted pig lead?

MR. C. W. WILES: That question was presented to the secretary at the request of a neighboring city of ours. They wanted to get some information on that subject as to whether lead wool had been used throughout the country on dry joints, and whether it was successful and as economical as hot lead. We would like to have the benefit of any information we may be able to collect as to experience with the use of lead wool in place of pig lead in making wet and dry joints on water lines.

MR. JOHN M. DIVEN: The speaker has found it so satisfactory, that in small jobs, such as setting fire hydrants, where there are only four or five joints to make, he has not used poured joints for some years; as you know, building the fire and getting the melting apparatus in position and operation would mean a large proportion of the work in the case of a small job as compared with the cost of the job.

The speaker had occasion to lay a line of 8-inch pipe under a railroad yard, some fourteen tracks in all, and in swampy ground. Great trouble had been experienced with pipes under tracks in similar situations and Ward joint pipe was used for this job. As a test of lead wool half of the joints were made with it, the other half being poured in the usual manner. Leaks soon developed in the poured joints, but none with the lead wool ones. Great care was taken in laying the pipe to grade, to get full joints and the lead wool was caulked in strand by strand, so that it was solidly compacted for the entire depth of the joint, something that was not possible with the poured joints. No gasket was used in either the lead wool or poured joints.

MR. OSCAR BULKELEY: The speaker used lead wool on lines of pipe from 8 inches to 12 inches in diameter, but gave up its use because caulkers could not do the heavy work required in caulking lead wool by hand. It's a long, tedious job. However, the speaker is of the opinion that lead wool may be used successfully by caulking with a pneumatic hammer.

4. Is it your practice to test new water meters or meters repaired at the factory, or do you rely on the factory tests? If tests of such meters are made, do they indicate that the new or factory repaired meters are accurate, or not?

MR. THEODORE A. LEISEN: In Detroit we test every meter before it goes out into service, and with very few exceptions our tests come up to the factory tests; in other words, we figure on getting within $1\frac{1}{2}$ per cent of absolute accuracy before the meter goes out, and we usually get that.

MR. A. A. REIMER: The speaker thinks there ought to be a very close agreement between the factory test and the shop test at our own plants, if the pressures and pressure conditions are nearly the same. For instance, in one case where the differences were as high as 4 to 5 per cent, it was found that the pressure fluctuated owing to the fact that at times in some other part of the factory the testing line was subjected to rather extreme changes in pressure, whereas our test conditions gave a practically constant pressure. As soon as those conditions were changed at the factory and they gave a

constant pressure, we got practically the same conditions and reached the same figures. We do not permit any meter to leave the shop and go into service until it has not only been tested but has met the requirements of the department for accuracy and delicacy absolutely. The repaired meters are also treated in the same way. As soon as a meter is repaired it is put on the test bench and brought up to proper specification requirements in every case.

5. Are meter bills of municipal water works a lien on property? If so, how are they regulated?

MR. J. N. CHESTER: That is a matter that depends on state laws, for in Pennsylvania they are, but in some other states they are not.

MR. GEORGE G. EARL; Our bills in New Orleans are a lien on the property by an enactment of the legislature. The lien has to be collected or filed in the mortgage office, to be protected against a sale of the property prior to its collection.

MR. J. N. CHESTER: That, we believe, is universally the case in connection with municipal ownership.

TOPICAL DISCUSSION

SERVICE PIPES

Experience with various materials, particularly steel or iron ungalvanized. Reasons for using iron or steel instead of lead; experience with material other than iron, steel or lead.

MR. A. A. REIMER: The speaker refrained from going on with that matter this morning because in that discussion certain remarks were made that did not seem to apply to the question particularly before the convention; but certain things were said this morning which the speaker wishes to reply to. Mr. Wilcox stated, or the practical effect of his statement was that there was nobody making wrought iron pipe today. Now the speaker's investigations in connection with the committee work for the Association have led him into several of the shops and foundries of the country; and he wishes definitely and positively to say that there are concerns making genuine wrought iron pipe. It will not do to give the name of any particular concern, of course, before the convention, we are not here for that particular purpose; but if any of you are interested in getting wrought iron pipe, that you will not have any bother with in using or testing it after you receive it, the speaker can tell you where you can get it and how you can specify it so that you will be sure to get genuine wrought iron pipe. You do not have to take steel pipe if you want wrought iron pipe, you can get wrought iron pipe and you can feel sure that you do get it. The speaker has specified a certain brand of pipe and received it with the maker's name marked on it.

MR. W. F. WILCOX: The gentleman misunderstood the speaker, who did not state that there was no wrought iron pipe to be gotten. He said he seriously doubted if there was enough wrought iron pipe to furnish everybody with it without putting them to considerable expense. It would seem that there are a great many engineers who undertake to lay a burden on the manufacturer which increases the cost of the work without there being any correspond-

ing advantage in so doing. Low carbon ingot steel will answer all the purposes of wrought iron pipe. The speaker does not remember the price, not being interested enough. He thinks in the majority of cases low carbon steel will be just as satisfactory wherever a man's local conditions do not warrant him in paying any extra amount or going to any extra trouble to get wrought iron; it is doubtful if anything is gained by going out of the way to get wrought iron. Hundreds of thousands of dollars have been paid out to test the comparative life of steel and iron. To go into the slightest discussion of that would bore the convention, and so the speaker will not undertake it, but he believes that any man in any city will do well to consider his own particular conditions.

MR. W. R. CONARD: Anyone who is using wrought iron or steel pipe can make a very simple test to determine whether they are getting wrought iron or steel pipe. Take one part of sulphuric acid to three parts water and immerse a short section of the pipe in the solution for six or eight hours. This will demonstrate very quickly whether it is iron, or steel, not positively always, but generally speaking, and quite conclusively. When you take the short section of pipe from the bath the pitting of the metal will show a more or less granular structure if it is steel; if it is wrought iron you will find a fibrous appearance. It does not take so very long to make the test, and you can demonstrate to your own satisfaction in that length of time just whether it is iron, or steel.

MR. W. J. HADDOW: You may profit by the experience of the machinist and arrive at the same conclusion in about two minutes with a hammer and chisel. The grain of the iron is arranged longitudinally; steel, as the previous speaker has said, shows little granular particles.

MR. C. W. WILES: Any man who cuts pipe or goes into a shop and puts a piece of pipe into the cutter can tell very quick whether it is steel or iron. Another method of test is by the use of a threading machine on a piece of pipe; the wrought iron will take a sharp, smooth thread. Wrought iron cuts and threads more easily than steel, and wears the cutting and threading tools less.

MR. RAYMOND W. PARLIN: The last speaker referred to something which has interested the speaker for some time. He has often

been told that even though genuine wrought iron pipe were specified it was very doubtful whether it would be received. Our foremen have often said that the pipe purchased in recent years was not as good as that which we used to get and their statements were borne out by the experience which two plants with which the speaker has been connected have had with its use. The old pipe lasted eighteen to twenty-two years while the newer pipe on nearby services went to pieces in from twelve to fifteen years. The speaker has several times noticed that the threads made by the dies on the newer pipe were not as smooth or as easily cut as those on the old pipe. This led him to believe that the metal in the newer pipe was a mild steel instead of wrought iron. Wherever trouble is experienced with internal corrosion of service pipes, and no corrosion takes place on the outside, it would seem that ordinary steel pipe lined with natural cement would be preferable to the wrought iron pipe generally supplied. Experience in Watertown, Massachusetts, and in several other New England towns indicates that this pipe will be practically as good at the end of fifteen or twenty years as when it was put in place, while the best wrought iron pipe often fills with rust within a few years. Such pipe can be purchased in quantity and lined by the repair forces when there is nothing else to do. The cost should not be more than that of the best quality galvanized wrought iron pipe.

MR. A. A. REIMER: Another interesting test can be made by those who have machine shops, you can make it very easily, take a piece of steel pipe and then get a piece of wrought iron pipe, and make sure that it is wrought iron pipe. Put the pipes on an emery wheel and you can see the difference in the sparks that are produced in the case of the wrought iron as compared with the steel. You will be surprised at the difference you get in those sparks. That is about the simplest test that you can work with for a quick test. You will never be fooled, because low carbon steel cannot possibly make the same kind of sparks that the wrought iron pipe will. That is one of the most positive tests that have been found up to the present time. In our committee work, this is one of the points that we brought up in connection with wrought iron and steel, and after you have seen the sparks once you can never be fooled.

MR. J. M. DIVEN: Let us hope that, when the committee makes its final report, there will be a recommendation that the manufac-

turers will follow, that every pipe be stamped, so that we will know who made it. As to the small demand for wrought iron pipe and the prices paid, no doubt the demand will be met by the manufacturers.

The speaker's experience in buying old-time pipe in the open market, as against the present steel pipe, is, that the old-time pipe would last about double the time of the new. We were sure that it was wrought iron pipe, because there was no steel pipe made then. We do know that there are certain manufacturers that do not make anything but wrought iron pipe. You are safe in buying from them; but in buying from the dealers you cannot be sure what kind of pipe you are getting unless there is a requirement that the name of the manufacturer be stamped on every length of pipe.

MR. R. J. THOMAS: We are using mostly wrought iron pipe for large services and driving wells, and have never had any difficulty in getting all we want. In buying, we specify that no pipe will be accepted unless every length is branded. The speaker is surprised to hear of any difficulty in obtaining wrought iron pipe. We buy a carload at a time. Of course the price is higher than for steel pipe but it will last longer and wear better. Occasionally we have tried steel pipe but it has not proved as satisfactory as the iron. From our experience, confirmed by the experience of others, as found in papers read here, and from those who have made tests for a length of time of wrought iron pipe, it has proven satisfactory. In regard to services for inch pipe and $\frac{3}{4}$ inch pipe we use lead lined iron pipe.

CARE OF VALVES

Packing and material used for packing; Lasting qualities of various packings; Setting of valves to permit packing without digging up the streets; Oiling valves, both stuffing boxes and gears.

MR. M. L. WORRELL: In regard to material used for packing valves, the most satisfactory one, one that has you may say life everlasting, is lead wool. Once you pack a valve properly with lead wool, your job will stand forever, something else will have to give way before it does.

MR. WILLIAM LUSCOMBE: Will the speaker please tell how many years he has used lead wool for packing valves?

MR. M. L. WORRELL: Since it was first put on the market, and have never had to pack the same valve again. Do not recall how many years ago that was.

MR. A. A. REIMER: That sounds good, but the speaker thinks we ought to have a little longer period of time to prove its value. We need the test of time. With us we specify high grade Italian hemp packing laid in tallow. We have had a twenty-five years test of that without repacking except for examination, and on the examination we found the tallow still has lubricating value.

SECRETARY DIVEN: Have you ever tried graphite mixed with the tallow?

MR. A. A. REIMER: Recently we have been adding that too; but do not think it necessary.

MR. W. J. CONNOR: Does the gentleman who suggested lead wool use any graphite or lubricant with the lead wool?

MR. M. L. WORRELL: In some cases, and in some not. The speaker has not found any difference in the work. It was the idea of one man we had to use both oil and graphite mixed with the lead wool, but it was rather mussy, and it makes just as tight a joint without.

MR. W. E. HASELTINE: Have you tried lead wool for packing fire hydrants?

MR. M. L. WORRELL: No, sir.

MR. CHARLES McDONALD: Have the members who used lead wool had occasion to open up and examine the job very often?

MR. M. L. WORRELL: The way we came to use lead wool the first time, was because we had not anything else handy to use out on the job, and it occurred to the speaker that it would be a good thing to try. He had not looked into it before, but used it again, and at the present time the engineer at the pumping station is using it; with a metallic packing, it answers the purpose very well. We are using it on both large and small valves.

A MEMBER: In 1907 we took out about 475 valves from 6 inches to 12 inches inclusive, and on repacking lubricated with tallow and graphite. We have examined the valves and the packing occasionally, and it seems to be in apparently as good condition now as it was when the packing was first placed. The valves, most of them, have been operated only at stated intervals when they were opened or closed.

SECRETARY DIVEN: Another question which might come up in this connection is whether the valve as it comes from the factory is packed as it should be with durable packing, or whether the valve should be repacked before putting it in service?

MR. RAYMOND W. PARLIN: While operating a plant in the Middle West it was found necessary to repack practically all of the valves even before they were put in place for the first time, as the water in the system corroded the valve stems, so that, on opening or closing, the packing was cut out and leakage started. In repacking the foreman used a small tight-fitting lead washer, followed by packing made of either lead wool or hemp, lubricated with graphite or graphite and oil, with another small lead washer on top of the whole to keep it in place until the packing nut could be well started. The main dependence was placed upon the graphite in this packing, and the results seemed to be very satisfactory.

The foreman who had had a number of years' experience with this material was of the opinion that no further trouble would be experienced.

OWNERSHIP OF METERS

A general discussion of who should own the water meters, and experience with publicly and privately owned meters. Care of privately owned meters.

MR. GEORGE HOUSTON: On the question of the ownership of meters, in order not to take up any more time than necessary to cover this point as thoroughly as possible in the fewest words, the speaker will read an extract from a paper of his that was read before the Central States Water Works Association at Cleveland in 1911, with reference to the ownership of meters.

Some contend that it is best for the municipality to retain the ownership of meters for the reason that it gives the city full control in the care and inspection of them, which it could not have were they owned by the consumer. We do not agree with those who hold this view, as experience has taught us that it makes no difference whether the city or the individual owns the meter, and, as fully ninety per cent of the meters in use in our city are privately owned, we feel as though we are quite well posted on the question.

When we first began the installation of meters we thought best that the city should own them, but we soon found that people were very careless about protecting them, particularly against frost, and as we were put to a great deal of trouble as well as expense by reason of such carelessness we set about to find some way out of the difficulty. We finally hit upon the plan of giving the individual the privilege of either buying a meter outright, or renting it. If he buys it he gets it at cost, and if he rents it he is charged an annual rental of 25 per cent of the cost of the meter and setting same, but is given credit for 40 per cent of all rents paid, which will pay for a meter in full in ten years. This, as you will probably conclude, is a modest way of forcing the people to own meters, but it has worked out nicely with us.

In handling matters in this way we have never had to make an appropriation for the purchase of meters except the first one of \$4000, as the moneys received from rentals and the sale of meters has enabled us to keep the wheels revolving, and have a supply on hand at all times, and as we buy them only as we need them, they are generally disposed of before the bill comes due.

We have never had any more trouble exercising full control over privately owned meters than we have over those owned by the city, and we find that parties who own their own meters, as a rule, take more pains in the setting and care of them than do those who rent them.

It might be well to state that we do not rent meters that are above 1½ inches in size, but require them to be paid for when installed, and so do not have any large expensive meters on hand.

If conserving the supply of water, by a complete metering of plants, were to be followed out by many of our cities, where a shortage of water now exists, it would be found, as we have found in our case, that they have an abundant supply for all present needs and will have for many years to come.

This paper was written three or four years ago, and the practice mentioned has been followed ever since, and the speaker doubts very much if you could go to our city and by vote of our meter users or water takers have the plan changed now, because they prefer to own their meters, as a rule.

MR. SEABURY G. POLLARD: Who repairs the privately owned meters under those conditions?

MR. GEORGE HOUSTON: The city, charging cost for the parts.

MR. GALLAGHER: Do you charge for the actual cost of repairs in addition? Do you charge for the time of the man making the repairs?

MR. GEORGE HOUSTON: Yes, in some cases.

MR. CHARLES E. McDONALD: Does the cost of repairing the meters become part of the cost of the water bill, or is the owner of the property sent a separate bill for repairing the meter? Does the cost of repairing the meter become part of the main water bill that remains unpaid?

MR. GEORGE HOUSTON: Of course we never file any bills as a lien upon property. If they fail to pay bills on time we shut the water off, and it remains closed off until some one pays the bill. We have had bills of that kind where the water had been shut off for ten years on account of non-payment of bills, and the claim followed the property right down. We have never had any trouble at all. In seventeen years our collections have averaged approximately \$40,000 for water and we have now uncollected less than \$300, \$240 as the speaker remembers it. The delinquent water bills are all collectible and will be paid up in a very short time.

A MEMBER: In that case, suppose a consumer should pay the part of the bill covering the water consumed, and refuse to pay the part of the bill covering the repairing of the meter, would the water be shut off just the same?

MR. GEORGE HOUSTON: Just the same. We refuse to accept any part of the bill unless the whole is paid. We have two methods of collecting for repair of meters. The city does not take off any meters that have been damaged by freezing; they require the property-owner or some one for him, it may be the plumber or any one else, to bring the meter to the office. Our men then repair the meter and we make out a bill and attach it to the meter and some one has to pay that bill before the meter goes out. In that way we have no big account for meter repairs to keep track of. In every case when repairs are made, for cause other than freezing, the meters are put back into service and a report of the time and material is made to the office. We add that to the next outgoing bill

and it has to be paid at the same time the bill for water is paid, regardless of whether the bill is being paid by the renter or by the owner of the property. If the renter pays the meter rental or repair bill, and is under obligation to the owner to pay the water bill only he usually collects or deducts the amount paid for the meter repairs, or rental, or both, as the case may be from the next rental paid for the property; so that in that way it balances up very nicely and makes no trouble to speak of. We certainly have gotten along nicely.

A MEMBER: In your charge do you charge back to the property owner in all cases, or to the consumer?

MR. GEORGE HOUSTON: Everything is charged against the property.

MR. THEODORE A. LEISEN: Do you take similar action in regard to a frozen meter or when it is damaged by hot water?

MR. GEORGE HOUSTON: The same procedure. We do not permit the meter to be taken out of the shop until the bill is paid.

A MEMBER: What is your method of adjusting bills, for the time meters are out for repairs.

MR. GEORGE HOUSTON: We average it.

A MEMBER: Do you average the daily consumption from the time it was put in up to the next regular reading?

MR. GEORGE HOUSTON: As a rule we take the average consumption during two quarters and then we average for two quarters; we take the quarter at the expiration of which the meter was taken to the shop for repairs and the quarter following, that is when it was reinstalled after the repairs.

A MEMBER: The speaker has been in the habit of charging for it during the quarter succeeding when the meter was taken out.

MR. GEORGE HOUSTON: Our ordinance provides that we are to follow the method of taking an average for a charge basis. "Or

other available information." Sometimes we have to deviate from the regular course, but very rarely.

MR. WALTER L. WATSON: Where does the consumer get his meter? Must he buy it from the city or any plumber, does he use his own discretion as to the make of meter?

MR. GEORGE HOUSTON: The city reserves the right to furnish the meters; they have to get them from the city from the smallest up to the largest size. We have for a good many years had three different kinds of meters from which they can make selections; so that not any one single kind is adopted as the standard meter or the one that they have to take.

MR. PATRICK GEAR: Would the last speaker state if when he has a meter that has been running along four or five years he then takes it out and inspects it.

MR. GEORGE HOUSTON: Once in a while we do but, not as long as the bills are running along in about the same ratio. If indicated consumption starts to go down when a party has been constantly quite a heavy consumer, we have the meter inspected to determine the cause, if possible.

MR. PATRICK GEAR: The speaker would like to know how you get around a case like this. Suppose we installed a meter in a building, which was occupied by the owner himself, his wife and a maid, and after this meter was put in it registered about 30 gallons per day per capita. During the summer months in the lawn sprinkling time, the meter registered 450 gallons per day per capita, and then the consumer would claim that there was something the matter with the meter. After a few years of service this same meter would come down to a basis where it would run about 75 gallons per day per capita and the consumer would claim that the meter was all right. But if you would look and see the condition of his lawn, you would surely say that the lawn was very fine, and the meter was no good. Of course we all know that every one likes to praise their own method. If a city or town rules that the consumer must buy his own meter, and those meters are sold at different prices, there is not any doubt that he will buy the cheapest meter, although

it may not be the best one. You will have a lot of trouble in keeping tabs on cheap meters, seeing whether or not they are doing the work laid out for them, and finding out if they come up to the standard. Any meter that has been working regularly for five or six years, should be taken out and tested.

In our city the manufacturing plants run pumps and when these pumps get out of order, the meters installed there must do all the work. In some of the plants the meter will register 200,000 cubic feet for one month and the following month may run 60 cubic feet, which would indicate that the meter was stopped. When we send out the bill to them estimating it on a six-months' basis, the manufacturer will come in and say that he did not use the amount charged for, and rather than have any trouble with him we cut it down some.

If the consumer owns the meter he may take it out when he pleases, but if you should want to take it out for a test, he would tell you very quickly that the meter belonged to him and that you had no right to touch it. Then all your troubles would start.

MR. FRANCIS C. HERSEY, JR.: In regard to the first part of this question as to whether the city shall own the meter, we could find out very quickly the situation in the places represented by officials here by asking first of all those who live in places where the meters are owned by the water works to stand up, and then ask all those who live in places where the consumer owns the meter; and this vote might shed some light on the question.

(Vote not taken.—EDITOR.)

MR. W. E. HASELTINE: That might be all right if we all approved of the method that we ourselves are using. In our case the consumers own the meters, but the speaker does not believe it the proper system.

MR. GEORGE HOUSTON: Mr. Gear ought to have entered the profession of the law rather than the business of managing a water plant, for he certainly would have made a very good lawyer. He asks questions in rapid succession and then he suggests the answers and draws the conclusion himself, that the only way for a city or corporation to have any control over their meters, without getting into a row with the man's wife or the man himself, is to let the

municipality or the corporation own them. Now the speaker stands here to say to you that a whole lot of the trouble that every water works man has is due largely to his own personality. If you do not believe in your own system, if you do not believe it is right, you certainly will have a hard job convincing the people that it is right; but if you are soul and body given over to the idea that you are right and what you are advocating is right, you will not have any trouble in convincing the people. We probably have less trouble in Kalamazoo over our right to take off a meter and look after it than is had in any city in the country, whether the meters are owned by the municipality or a private company, or by the individual. We simply give them the right to pay for the meter if they want to or else pay a rental to the city for the meter; but we control it just as much as if it was owned by the city itself. We certainly have less trouble along the line of getting the consumers themselves interested in the meter than we would have if they did not own it. It does not make any difference whether a large majority of the people here at this meeting live in cities where the meter is owned by the municipality or the corporation, or whether they live in cities where the majority of the meters are owned by the individuals; that does not make any difference as to the right of the question. As said in the speaker's first talk, it depends upon the individuality of the man whether he has trouble or whether he does not. The last gentleman that spoke said that in his city the meters were owned by the consumers, but he did not believe in it. He will have a hard time, the speaker will guarantee, in getting meters out of a man's place unless the city owns them, when he wants to inspect the meter.

MR. W. A. PATTON; If we were all situated as favorably as our friend in Kalamazoo, where they raise so much celery that all his patrons have their nerves quieted in advance, we might find that under those conditions we would be able to take out an under registering meter without a fight. But down our way we would have a law suit at the drop of the hat if we were to try it. The speaker therefore thinks it better for the company to own the meter, for then we can take out our own property without trouble.

MR. W. E. HASELTINE: In Wisconsin we are controlled by the railroad commission, which is a big commission and an extremely

good one. We are also interested in gas and electric property. We own our gas and electric meters. We would not allow consumers to own them if we could help it. We want to own the meters ourselves. It is much more satisfactory in the case of gas and electric companies and the speaker does not see why it should not be equally so with water meters.

MR. C. W. WILES: We have about 90 per cent of our meters owned by the company and 10 per cent owned by individuals. The speaker is free to say that he does not know whether we could stop them from buying meters or not; but has not tried to very much. If a man wanted to own his own meter the speaker has said, "All right," but he does believe in the ownership of the meters by the company; for this reason, if you have a meter that has been running along five or six years and you go over your books and find that the meter has been dropping behind, that meter ought to come out. We took out over forty this spring, because we thought they had been running longer than they ought to run correctly.

We found that 75 or 80 per cent of those meters had been running slow, so we took them out without asking anybody's permission. We simply recorded on our books that the meter had been changed and another meter put in. We did not go to the owner of the property about it and say, "We are going to take this meter out;" we simply go and take it out and put another in its place. If you were to take the meter out without putting another in its place you would have to estimate the consumption until such time as you did place another meter. One advantage of the company owning the meter is that there is no controversy over its ownership. If the customer owns the meter and it freezes you will have trouble when you go to take the meter out and average the water that is used while it is out. If you own the meter you do not have any trouble.

MR. GEORGE HOUSTON: Why don't you repair it in the first place? How many did you send back to the factory?

MR. C. W. WILES: We sent back fifty of them last year.

MR. GEORGE HOUSTON: Then your repair shop is not what it ought to be.

MR. C. W. WILES: We cannot repair a badly sprung brass meter, we have no appliances for bringing such a meter back to place. Most of those that we have had to send back have been large size meters. We find that it is much more convenient to take the meter out and put another in its place and then repair the one taken out when we get ready.

MR. GEORGE HOUSTON: Mr. Gear said that if the consumer paid for his own meter he would always select a cheap meter in preference to a better grade. We have meters that we sell for \$6.75, \$7.00, \$7.50, and \$8.75 for the $\frac{5}{8}$ inch size. Since the 17th of last June we have put in approximately 500 meters on lines where the people bought them. There has been but one of the \$7 meters put out, and about three of the \$6.75 meters, and they were put on places that the Board of Health had ordered connected with sewers, and insisted that a water supply be carried in. The properties in two of these cases had been taken over by foreclosure of mortgages, and were owned by men who lived east and they wanted the cheapest meters they could get. It is *not* true that the Kalamazoo people buy the cheapest, even if they do eat a lot of celery.

MR. HENRY P. BOHMANN: Milwaukee has about 161,000 meters in service, all of which are owned by the consumer. The speaker wishes to go on record that meters should be owned by the city. Our experience has proved that to be the correct position.

The Railroad Commission of Wisconsin has in every instance ruled that the utility must furnish the meter, and a special ruling was necessary for Milwaukee, for the reason that we would have been obliged to purchase a lot of old junk in order to get possession of the privately owned meters. The water department started out correctly. Mr. Benzenberg, city engineer, at that time, had charge of the water department, and selected what he considered the best meter. Several aldermen who happened to be plumbers were anxious to get the agency of different meters, and finally succeeded in getting a resolution through the common council compelling the consumer to furnish the meter. As the result of their activities we now have about thirty-five different makes of meters in service, good, bad and indifferent; whereas if the department owned and had the selection of the meters we would have confined ourselves to about two or three good types. The meters are furnished by the

plumbers, who charge anywhere from \$10 to \$20, whereas if the department owned the meter we would buy in large quantities and would furnish them for \$5 or \$6. Indirectly that would be of benefit to every consumer. We have thirty-five meter readers who read the meters monthly and report as to how they are registering. If they are not registering properly the next step is to take out the meter, send a written notice to the consumer, and ask him to sign the notice to have the meter repaired. The party has ten days to sign and send in that notice. If he happens to be a tenant it usually requires ten days before the notice comes in. In the meantime the meter is waiting in the shop. After the expiration of ten days it is repaired, and then it necessitates a second trip to replace that identical meter. In the meantime the water registrar is advised that the meter has been taken off temporarily and replaced, and then the account is averaged. This is a simple proposition in the ordinary residence; but out of our total revenue one-half is paid by one hundred large consumers. We have a number of them that are paying from \$20,000 to \$25,000 annually. It is very difficult to find a proper way or method of averaging the account when the customer is using from \$25,000 to \$75,000 worth of water a year. We notice that whenever a meter is taken off it is always claimed to be during the dullest season. The fact that gas and electric utilities furnish the meters is pretty good evidence that the water departments and companies should follow suit.

MR. GEORGE HOUSTON: Did you ever have or hear of meters that were owned by the city, those large meters, that would stop and would necessitate averaging the account?

MR. HENRY P. BOHMANN: No, the department keeps a sufficient number of meters on hand, so that when a meter drops in registration and we have to repair it, we take off the defective meter and immediately replace it with another meter, then the defective meter is brought into the shop and put in shape. Under our present conditions we have to replace that identical meter.

In case of meter repairs, we charge only the actual cost of repair, of which we keep a record of each particular job; then we charge the overhead expense. A meter repair job is like a doctor's bill, it comes unexpectedly; it is always unsatisfactory. We are spending something like \$60,000 on meter repairs yearly. The speaker

has a meter in his house that has never cost one cent for repairs. He would be willing to assign the ownership of that meter to the city with the understanding that they would replace it every time it needs repair; and does not see why every property-owner cannot assume the same position.

MR. H. B. MORGAN: The question of who should own the meter—the water department or the consumer, is probably troubling most of us. The speaker's experience is that the meter should be owned by the water department, for the reason that we then would have full control of it, and, if for any reason it became necessary to remove a meter and put another one in its place, we would not be compelled to argue with the consumer as to its condition, as in a great many cases you would have to do if he owned the meter, and in nine cases out of every ten you would utterly fail to convince him that his meter was not correctly registering the water passing through it.

At one time some of our consumers owned their meters and we always experienced a great deal of trouble whenever it became necessary to remove one for repair or to put another in its place.

In one particular case where the then manager of our company was discussing with the consumer the condition of his meter and the necessity of removing it for repair, he told the consumer how hard water acted on the brass in the meter and caused the meter to slow up and in many cases to absolutely stop. The consumer said to him, "Well, if your water has that effect on brass, what effect will it have on my stomach?" The manager was stumped for a second and then replied, "Well, your brass is not in your stomach."

Mr. Chairman, the speaker did not expect to enter into this discussion, but finds that he will have to keep out of this convention if he wants to keep out of discussions.

MR. WALTER L. WATSON: Somebody has well said that the consumer should not be expected to pay for the meter that measures water any more than as a patron of a grocery store he would be expected to pay for the scales that weigh the sugar.

MR. PATRICK GEAR: The speaker finds great pleasure in sitting down with his friend from Kalamazoo, and talking about the water department of that place. His department is something like ours

was some years ago. An old man who came to work for the department from its foundation was working in the street one day when a traveling man stepped up to him and said,

"Is this a municipal department, or a private corporation?"
"No, it belongs to John O'Brien and Mr. Hardy."

Now it would seem that it is the same in Kalamazoo and whatever this friend says is law in his town.

Mr. Kirkpatrick, who was the former superintendent and who is now manager of the City Gas and Electric Department, wanted to buy the 6-inch meter installed at his plant, but our department would not sell it. If we did sell it we would lose the \$60 per year rental charge.

SECRETARY DIVEN: Does the \$60 rental pay for any water?

MR. PATRICK GEAR: That is for rental on the meter. He used a large amount of water on the Fourth of July, so that we will get \$5 for the water used and \$60 for the meter.

From two concerns that we charge \$40 rental on a 4-inch meter, we receive about \$10 for the water used. You can see that if they owned the meter we would lose the rental charge.

It seems in this convention that it is very much the same as what General Hancock said when he was running for President, in the year 1880; he said that the tariff was a "local issue." The meter question is a local issue, and must be handled according to the conditions existing in the different cities and towns. Everybody thinks that his own department is all right. The speaker never had any trouble with the people in Holyoke, but was afraid that our friend from Kalamazoo may have in his town, and wanted to advise him to come over on the popular side of municipal ownership of meters.

MR. E. E. DAVIS: Probably the experience of my town dates back with regard to meters farther than that of any city in the United States outside of New York. The first meter that ever came to Richmond was made in 1858, and was a 1-inch meter and weighed 500 pounds. It was too "bunglesome" and too heavy. It was tried for a while but never was satisfactory. In 1874 Mr. John Kelly came to Richmond and the superintendent of the water works gave him an order for four meters. The speaker was the plumber

for the department at that time and his duties being almost anything from superintendent down to plumber, he put the meters in that we bought from Mr. Kelly and used them to test for waste. We also bought a $\frac{3}{4}$ -inch Hartford meter put it on a livery stable where the man was paying under the ordinance \$65, and the meter reading at the rate of 25 cents per 1000 gallons made his bill run up to \$125. So then we started to convince the city council that there was a great deal of waste; but they would not be convinced. In 1888 the city set aside \$1000 from its construction account for meters, giving them to parties that asked for them, and charging them \$2 a year for the use of the meter and 25 cents per 1000 gallons for the water. The large factories began to see where they could save money provided that the city would reduce the rate, and they put in their own meters. We were charging \$2 a year for rent of meters, but the city attorney decided that we could not collect that because we charged in advance; so the \$2 rent was taken off and the parties that got meters from the city paid the regular straight rate.

A good many years after that our pumpage rose to a tremendously high figure while the pressure was going down. The speaker made numerous tests to demonstrate to council that waste was going on and that meters should be adopted; but they decided then that they would not take any action but would allow the people to purchase their own meters, and a great many people bought meters. The lowest bill that any of them had was \$3.38 a quarter ordinance rate. We charged by the month, and the majority of the bills were reduced to 65 to 75 cents a month, through meters. One man paid \$1.68 a year for water through his meter. An old man on a side street, that ran a shoe shining place, did not get any reading from his meter and he paid 38 cents for the entire year. We finally got the city council interested in the idea that waste was going on, and they voted us \$15,000 to purchase meters. We put the meters on, and charged a flat rate of 15 cents per 1000 gallons. Everybody was working then for the meters. The question arose as to the meters purchased in between the time that we originally purchased when we paid \$13 a piece for them as to whether a cheaper meter would be acceptable to the city. That was in the days before the disc meters were invented. After the disc meter came in we stopped buying them for the consumer and let the consumer buy for himself. The city would put in the meter, and then the question would

come up as to who was to pay for it. That question has been up since 1885, but never decided.

We have tried every way in the world to find out which is the best way of controlling the meter? The city puts in the connection between the street and the property, but the plumber furnishes the lead pipe to make that connection. We furnish the meter and put it at the curbstone. We charge them a minimum rate of not less than \$8 a year. If a consumer wants a meter put in for his premises larger than 1-inch he pays the cost not only of the meter but the connections, outside of the labor. The fire underwriters and insurance people have all been jumping on the speaker because he has positively declined to allow an insurance connection larger than 6-inch for fire protection.

Another question that has come up about meters is as to who shall keep them in repair. The city of Richmond keeps all meters in repair up to 2-inch. If a meter larger than 2-inch is found not working due to wear the necessary parts are ordered from the factory and the bill is sent to the consumer. If a consumer has two connections in his house the city furnishes him one meter, and he buys the other. He does not know what kind of a meter he buys because the agents in Richmond all charge you the same for all kind, \$8.40 for $\frac{5}{8}$ -inch meters.

Municipalities that own their water works should own the meters, because then there is no question about the repairs or anything else. We put meters on to prevent waste; the city of Richmond has saved nearly a half million dollars for a reason that all of you gentlemen are familiar with. If you are going to furnish water at flat rates with no restriction except individual inspection you will make a serious mistake, for meters are inspectors in themselves and always on the job.

If a meter stops we average the bill, and settle on a basis of the average for the preceding six months; or if the consumer objects to that method we will let the meter run for thirty days and make the average in accordance therewith.

We endeavor to keep the meters in the best condition that we can. Sometimes they can be repaired right at the customer's premises; at other times it is necessary to send them to the shop.

Having had experience with meters since 1874 the speaker thinks it is best for the municipality to own the meter; or if it is a private meter the city should control it and keep it in repair.

CURB COCKS

Necessity of installing, their use and care; advisability and practicability of placing shutoff in the streets, at or near the main, to take care of service leaks outside of the curb line; cost of street boxes, keeping record of them, etc., as compared with curb boxes.

MR. J. M. DIVEN: When the speaker started in the water works business the service shutoffs were all at the main, and about his first work was locating and making records of their location. Later the shutoff boxes were all removed to the curb line, curb cocks being installed. It was at times difficult to locate and clear the shutoff boxes in the street, and it was thought that by putting the shutoff at the curb all troubles would be ended, that even the record of their location would be unnecessary. This proved to be a mistake, as even at the curb there are troubles and records of locations are nearly if not quite as necessary as in the street.

Troubles with leaks between the curb and main have led the speaker to wonder if there might not be some advantages in having the shutoff at the main. It is often necessary to dig up the street to shut off a service at the corporation cock, or to shut off a block or more of main pipe, to make repairs to a leaky service when the leak is outside of the curb cock. A shutoff at the main would obviate this and in many cases save cutting two holes in a pavement, as the one over the leak would be the only one necessary. Shutting down mains is not good policy and should be resorted to as seldom as possible; then too such shutoffs do not please the consumers, who are put to considerable inconvenience and annoyance.

Heavier boxes would be required if located in the street, and the question is whether the cost of extra excavations and the annoyance of shutting off sections of the distribution will offset the additional cost of shutoff boxes located in the street.

MR. OSCAR BULKELEY: The speaker would like to bring up the question of the method of manufacture of lead service pipe. He believes there is no standard of manufacture at present. There is no uniformity in the hardness of pipe that is furnished, and, when put up in reels, the joints that were made when two lengths of pipe were connected in process of manufacture are often found to have been very poorly made, so that the two ends of pipe joined together

in the reels may actually fall apart when subjected to slight bending. It would seem that the lead flange union couplings which are being used to a large extent now require a more uniform quality of lead than the old wiped joint. The speaker believes that standard methods of manufacture should be adopted for lead pipe.

SECRETARY DIVEN: Frequent attempts have been made to get information concerning the manufacture of lead pipe, especially standards as to strength, that is, the heft or class of lead to use for the different sizes, along the lines of the standards for cast iron pipe. We are in the habit of purchasing AA, AAA or even heavier pipe, without any regard to the size, though in the different classes the thickness of wall of pipe is the same for all sizes. It does not seem reasonable that as thick pipe wall is required for a $\frac{3}{4}$ -inch pipe as for a 2-inch, but we have no tests or standards to guide us in the purchase of lead pipe. What we need is a standard similar to the one established for cast iron, giving the class of lead to use for different sizes and different pressures. This report or standard could also include standard for quality of metal used, just as the specifications for iron pipe specify the quality of metal.

This question has been brought up with the manufacturers, but they seemed unwilling to go into the matter, and no member of the Association has so far been found to take it up; to make the needed tests and analysis of metal. Most of us are undoubtedly using the wrong classes of pipe, too heavy for small sizes and too light for the large, for we are mostly using the same class in all sizes. The Association will do a good work if it can establish standards to guide users of lead pipe.

MR. M. L. WORRELL: Water pipe cast in 16-foot lengths has recently been put on the market, and the speaker has used some of it and found some economy in its use, about 78 cents per ton in 6-inch pipe, and would like to hear the experiences of others that have used it.

MR. J. M. DIVEN: As the weight of the bell is about 10 per cent of the weight of a length of pipe, there would be a considerable saving in weight of metal bought when longer pipe than the usual standard 12-foot lengths was used. There would also be a considerable saving in lead for joints, with 16-foot lengths there would

be a saving of one joint in every four lengths over 12-foot pipe. This saving is easily figured, both in material and labor, for the different sizes of pipe. In larger sizes the additional weight to handle might be a disadvantage; also, the lines would have to be straighter, as there would be less chance to offset at joints. The speaker can, however, give nothing from personal experience, but trusts that such members as have used the pipe in the new lengths will give their experiences. We all want to save all we can in our construction costs and are keen for any methods of manufacture of material that will assist us in this.

MR. W. F. WILCOX: The speaker is not a pipe manufacturer, but the company with which he is connected sells a great deal of pig iron to a foundry company. Probably the reason why the length has not been increased is because the smaller foundries have to build the spigot end of the pipe, and over a certain size your specifications require that a certain percentage of the spigot ends may be cut off.

The hardest part of the casting of pipe is to get rid of the honey-combed ends, and with the present methods 12 feet has been established as an economical length. The speaker believes we will save more money by letting the pipe manufacturers work out the pipe lengths for us than we would by attempting to dictate an arbitrary standard. The pipe makers keep a large laboratory and they study their manufactured product day in and day out. The speaker would rather have the opinion of some of the founders as to cast iron pipe than that of all of the testing societies there are. The founders live with the pipe, they know it, they are making the pipe and they know how to make it. They pile up all of their cast iron in different piles and each pile is numbered. A detailed analysis of each pile is carried, and they can tell you if you give them a number of pipe in the large size what mine that ore came out of, the day it was manufactured into pig iron, the day it reached their yard, how they made up that mixture, and the test both for tensile and cross breaking strain. They are anxious for any man that ever buys a foot of pipe to give them the history of any failure there is, and there have been instances where they have spent hundreds of dollars following up a small break simply because there was something in the pipe that, to the minds of pipe manufacturers, indicated that something had got by them in the manufacture of that pipe. The

speaker has seen pipe 36 inches in diameter sent back to the scrap yard after it had been accepted by the inspector in one of the largest cities in the United States.

If you will go to one of those pipe foundries for a week you will find out that they could reduce their percentage of rejections if they would turn over to you the pipe that your inspector is willing to take. The speaker has lived close to a pipe foundry and has been able to see how they study their manufacture. It is wonderful how they make pipe; the care, thought, and endeavor that they put into its manufacture.

Some large cast iron pipes break in the most peculiar manner. The speaker had one break of 17 inches. It was a crack right down on what he calls the belly of the pipe; a little rock not much bigger than the end of one's thumb did that. We used the hammer that the expert hammer men use in breaking up big castings to break that pipe, but could not do anything with the hammer. We put a stick of dynamite on the pipe before we could break it up.

The people who are making pipe are glad to receive any suggestions. It would be well for this convention to go to Birmingham and see how they make the castings and how they are endeavoring to make them the best they know how. They will be glad to have you join with them in making specifications to get the best results in the most economical and practical way. As the manufacturers develop and find that there is demand for a better pipe they will all try to meet the demand. Every man that has been in the water works business twenty-five years will tell you how they used to use wooden pipe in 1820, and the old men in the water works business will tell you how when the new-fangled steel pipe came out the older men said, "Well, we have been laying cast iron pipe a long time and we will let the boys try that new pipe."

Control of a pressure wave in an 18-inch water main $5\frac{1}{2}$ miles long from motor driven turbine pump. When power goes off at power station the pressure drops to 10 feet, and rebounds up to 420 feet, each wave less until pumping against a head of 267 feet with a friction of 32 feet on 299 feet.

MR. W. F. WILCOX: We had an experience with fluctuation of pressure in a 52-inch steel pipe which had a tendency to flatten as the speed of the pump plunger decreased and to assume a circular

shape when the speed of the plunger was at its highest movement. We put on an air chamber which had ten times the diameter of the displacement of the plunger, and ever since that time have had no movement in the pipe. The movement of this pipe was rather peculiar. The general manager sent a message one day to start out on that line and investigate why that pipe was moving two inches. The speaker went out and put pointers on it and set a level on top, and found that the pipe moved $\frac{5}{32}$ of an inch. But after watching it for some time it was found that it was moving an inch and a half. There was a crack right down the back for the entire two miles of the length of the pipe. The engineer with whom the speaker was located had advised anchoring the pipe. We anchored it with concrete anchors. We found the only remedy was to provide an air chamber of ample capacity to take the surges of the pump. We put a check valve at the end of the pipe next to the reservoir and air relief valves to relieve any air that might accumulate in the pipe. It is now five years since that pipe was laid, and we have never had to spend a nickel on it.

MR. GEORGE HORNING: The speaker has had some experience in controlling fluctuating water pressure in pipe lines, one, in particular, a description of which may interest you and also be of some information to you.

This occurred some 15 years ago, when the speaker served a company as general manager of three water works, two of which were being supplied by impounded water collected from a water shed extensive enough to create a lake of considerable dimensions. The main pumping plant was located alongside of this lake and delivered the water to both towns through a single pipe line 20 inches in diameter. The first town reached was one-half mile from the source of supply, and the other 20 miles therefrom. A stand pipe 8 feet in diameter and 140 feet high, was located near the first town and connected with the supply line in common to both towns. At the farthest town the water was received by a circular reservoir 100 feet in diameter and a depth of 12 feet. From this basin, the water was repumped by a second pumping station into a stand pipe 25 feet in diameter and 100 feet high, and connected up in the usual way with the distributing pipe system of the town. It may be well to note that the country is practically level for miles around, and absolutely devoid of any natural elevation for locating either

a reservoir, an elevated tank or a stand pipe; hence, as it was, the maximum amount of water that could be delivered by the pumping station to the farthest town was limited by the carrying capacity of the single line of pipe, and also by the head of water carried in the stand pipe.

It is obvious that under the existing arrangement, the town near the stand pipe would be well supplied with water and pressure, whereas the farthest one, would have its supply greatly restricted. These two plants, arranged as has been explained when the speaker was placed in charge of them, had been operated in that way some 18 years. The speaker soon discovered that the largest and farthest town was not being sufficiently supplied with water, and that the shortage was attributable to the lack of pumping capacity, and also to the carrying capacity of the long supply main and that consequently large expenditures of money would become necessary to give the proper relief, and to bring that about either a duplicate main would have to be put down, or the height of the old stand pipe greatly increased. To do the latter was found to be impracticable and unsafe, and to construct another pipe line would entail an expenditure of at least \$250,000.

On an examination of the pipe line in use, it was found that it had ample strength to sustain an additional water pressure of at least 25 pounds over that which was being carried. It was finally concluded to enlarge the pumping facilities at the lake and install an additional pumping engine of 5,000,000 gallons capacity, and to connect it, with the other engines at the station, to a 20-inch pump main so as to by-pass the water around the near town, using the stand pipe and a stretch of the old force main, with a pressure reducing valve properly placed, to supply the latter town. In this way a gravity main was converted into a pump or force main 20 miles long, which, with the higher pumping pressure made use of, furnished the desired amount of water to the second or farthest town.

The question arose with the contractors for a new pumping engine, whether it would be practical to pump directly at the proposed rate through this abnormal length of force main, so as not to burst the pipe by the oscillation of the column of water in such a long line of pipe.

The speaker explained to them how he expected to safeguard this pipe line against any water ram, which would be by the inter-

vention of an air vessel made of riveted steel plate, through which all of the water would be pumped. This air vessel to be located at the pumping plant, and to have a diameter of 5 feet and a height of 30 feet or more; and that a steam driven air compressor would keep the vessel supplied with air down to a point somewhere above the tops of the receiving and discharge nozzles riveted to the base of the vessel. The arrangements as detailed were successfully carried out, and after they were put in operation the expected results were fully realized, and continued so during the speaker's connection with these plants, which ended some four years thereafter.

A recording gauge showed that the terrors of the water ram so commonly accepted and feared by water works operators can be fully controlled and its damaging effects reduced to nil.

MR. E. E. DAVIS: We had a 36-inch pipe lying out on a lot for about two months. The keeper of the reservoir called the speaker's attention to a little crack on the end, about 4 inches long, which had passed the inspector. Six months later that pipe was cracked 6 feet, and it just kept on going; it was the only one of forty pieces of pipe that showed any such defect. One of them had a crack that barely showed. That pipe was laid out in the yard and six months afterward split open from atmospheric action.

The speaker had a very peculiar experience with an air chamber. He had the very difficult job of putting a 20-inch main in the bottom of a river. The river bed was composed of rocks. We put in concrete blocks and filled them up with rip-rap on each side so that the water would go over, and turned 90 pounds pressure on and it stood for some time. We reversed on the lower surface and put on 70 pounds. The speaker was called by the keeper of that reservoir who said that the water was all running out of the reservoir. Upon being asked, "Where is it?" He said, "On the 24-inch." Knowing what the trouble was, the speaker went down to examine the 20-inch pipe in the river and when he got there found that a piece had been blown out of the side of the pipe. It was a water ram that caused that. Two men ran away when the speaker came up, and it occurred to him that they had been shooting, and that possibly some wild shot or bullet had struck and burst that pipe; but he could find no mark of where any bullet struck. There was a 6-inch domestic sprinkler near by and the speaker went there to examine it and looked at it very closely. He called to the engineer and

asked him how he got the air in that sprinkler head, and was told that there was a valve cut in the shape of a funnel that fits over the top where the 6-inch pipe comes into the valve. When the water is on from the 6-inch water supply the pressure is about 90 pounds, but the air pressure is only 35 pounds on the sprinkler heads, and the difference in area of the valve that governs the 6-inch opening is sufficient to make up the difference of 55 pounds to the square inch on the contrivance that holds the valve. It was also stated that the valve could not be closed suddenly, but it was found that in trying the sprinkler heads when the air was exhausted it did shut off the sprinkler heads and the water supply very suddenly. The installation of an air chamber was insisted on and after it was installed the trouble ceased.

LEAKY PLUMBING

Enforcing rules concerning leaks in plumbing, by fines, shutting off water or other means.

General discussion of inspection of plumbing and reduction of leaks in unmetered buildings.

MR. JACOB KLEIN:¹ Investigation shows that more than fifty per cent of all waste of water in cities is due to leaky plumbing and to water loss from roof tanks. Leaking toilet tanks are the cause of a large proportion of this loss. Leakage in toilet tanks is not easily discovered, as some types are almost noiseless. Careless management within buildings, especially during periods of extreme temperatures when faucets are allowed to run full in order to draw the water, hot or cold, as required, is also the cause of the loss of a large amount of water.

Owners of buildings when installing their piping should be required to space the hot and cold water lines at least one foot apart. When owners make their application for use of water, they should be required to sign an agreement to prevent all waste of water and waive claims for damage caused by shutting off the supply in case of failure to comply with the notices to repair leaks.

House to house inspection to detect leaks in fixtures and unnecessary use of water in buildings has been found effective.

Inspectors assigned to examine plumbing in buildings should be

¹ Chief Inspector Bureau of Water, New York City.

familiar with its installation, and also have a knowledge of apparatus consuming water.

Notice should be left by the inspector with the owner or occupant when leaks are discovered, or when apparatus requiring water for its motive power is found in unmetered buildings. Notices in duplicate and carbon copied by the inspector in the field, have been found practical. When an inspector finds leaks on account of defective plumbing, or locates a water motor or ram in an unmetered building, a notice should be left notifying the occupant that the leaks are to be repaired and the apparatus removed within three days from the date of service, or a penalty of Two dollars per day would be imposed for each and every day such waste is allowed to continue. If the waste is allowed to continue after the imposition of the penalty, notice should be served that the water supply will be cut off.

Experience has shown that leaks are repaired by the consumer after the first notice is received, and it is only necessary to impose a fine in a small percentage of cases.

MR. J. M. DIVEN: The speaker fully agrees with what Mr. Klein says about leaking toilet tanks being the cause of a large portion of the waste due to leaky plumbing. As a test of this he on several occasions put meters on direct supply to toilet tanks both at his own residence and at waterworks offices. One such tank recorded a flow of over 1100 gallons per twenty-four hours. This tank had been specially fixed to cause the large leak, but while this leak was going on there was no annoyance, from noise or otherwise; nothing that would cause a consumer to repair the closet for his own protection. This, of course, is an extreme case, but is a possibility. The city pressure where the test was made ranged from forty to fifty pounds.

DISCUSSION

OBSERVATIONS OF SOME EUROPEAN WATER PURIFICATION AND SEWAGE DISPOSAL PLANTS¹

BY EDWARD BARTOW

A MEMBER: What amount of iron is in the Berlin water?

MR. BARTOW: About two parts per million, but they are very particular, they do not want any.

A MEMBER: At the Dresden plant, how much is the turbidity.

MR. BARTOW: The Dresden plant has a well water, which is clear when it is first drawn, the manganese separates on exposure to the air.

¹ Paper published in Vol. 2, No. 1, March, 1915, *Journal* at p. 13, etc.

DISCUSSION

THE YONKERS WATER SUPPLY AND ITS FUTURE DEVELOPMENT¹

BY D. F. FULTON

MR. EDWARD WEGMANN: Mr. Fulton has pointed out the difficulties which Yonkers encounters in trying to increase its water supply. The sources which would be suitable for this purpose have been acquired by the city of New York, and Yonkers is, therefore, obliged either to buy the additional quantity of water it requires from New York, at a high price, or to go to a considerable distance for a new supply. Under these circumstances there was nothing left for Yonkers to do but to develop its present sources of water supply to their utmost limit, and to trust that, in the course of time, a metropolitan water board, similar to the one of Boston, Massachusetts, will be created to take charge of the water supply of New York and of the nearby towns and cities.

The manner in which Yonkers intends to increase its present supply has been described fully by Mr. Fulton, and leaves little room for discussion. The only feature of the proposed work which involves difficult construction is the proposed earthen dam, which is to raise the high water level of the Grassy Sprain Reservoir 40 feet. This dam is to be built about 350 feet downstream from the present dyke, and will have a length of about 1070 feet, and a width on top of 24 feet.

If the speaker is correctly informed, the dam will have a height of about 90 feet above the surface, which will place it among the high earthen dams of America. Most engineers will agree that it is more difficult to construct a high dam of earth than of masonry. With the latter material, a leak through the dam causes usually only a loss of water; while with the former material, a leak may lead to the failure of the dam. In order to prevent undermining an earthen dam should be provided with a masonry or puddle corewall, which should be carried down to an impervious stratum.

¹ Paper published in Vol. 2, No. 1, March, 1915, *Journal*, pp. 1-8.

At the site selected for the Yonkers dam, rock lies at a distance of about 90 feet below the brook, and as the rock valley is wide, there is a large quantity of material overlying the rock. This material is sand of varying degrees of coarseness, and much of it is so coarse, that water flows freely through it.

It would be very expensive to dig a foundation trench to rock for a corewall through such material. Mr. Fulton states that it has been suggested to obtain a cutoff for the dam "either by driving steel sheet piling to rock, or, in the deeper part of the valley, by sinking a connected series of caissons and filling them with grout or concrete." If the material overlying the rock were uniform, that might possibly be done. But the speaker is told that this material is a glacial drift, containing more or less boulders. It is very doubtful, whether steel sheet piles could be driven 90 feet deep through such material, so as to make a practically watertight cutoff. If caissons were sunk, the work would not only be very expensive, but would involve much difficulty in getting the caissons down vertically to rock, so as to make a tight cutoff. Quicksand or a sliding of the sand, would deflect a caisson from the desired position. At the Hauser Lake dam, caissons for a cofferdam were sunk to a depth of 70 feet, but that was through water. It would evidently be more difficult to sink a caisson through sand, quicksand and boulders to a depth of 90 feet.

In drawing attention to the difficulties that will, doubtless, be encountered in constructing the proposed dam across the Grassy Sprain, at the site selected, the speaker does not wish to imply that this work is impossible, but it will be very expensive, and if it is not done properly may lead to the failure of the dam. The present Grassy Sprain Reservoir has been formed by an earthen dam constructed on similar ground to that at the site of the proposed dam; but it stores only about 50 feet of water, and when the depth of water at the dam is raised to nearly 90 feet undermining of the dam may occur, which would not take place with the lower head.

Many failures of earthen dams have occurred, even when these works were built by good engineers. The terrible diaster caused by the rupture of the Johnstown dam in Pennsylvania is the worst case of this kind that has occurred in America. This dam was 70 feet high. It was ruptured by water flowing over its top, after an unusually heavy rainfall. In England one of the most notable failures of an earthen dam is that of the Dale Dyke dam, which

was constructed for the Sheffield Water Works. This structure was 95 feet high by 1254 feet long. It was 12 feet wide on top and about 500 feet wide at the bottom. Both slopes were made $2\frac{1}{2}$ to 1. In the investigations that took place, after the rupture of the dam, the greatest engineers of England testified as experts, but their opinions, as regards what started the failure, varied very much, and this question was never finally settled.

DISCUSSION

THE ACQUISITION OF PRIVATE WATER PLANTS BY MUNICIPALITIES¹

BY B. M. WAGNER

MR. EDWARD WEGMANN: This paper is an excellent one. While most of the facts are known to people who have studied the subject, it would be very interesting if there were a bibliography of all the articles that have been written on the subject of valuation. Recently the speaker had occasion to make a valuation of six water plants that the city of New York is about to acquire, and the rule given by the corporation counsel was to find the reproduction value minus depreciation. In doing this it was not a question of one man's opinion, but the superintendents of at least five of these companies carefully went into the matter and gave their ideas. The object was to get a valuation that was not the opinion of either party, but would give the Board of Estimate and Apportionment an idea of how much it would have to pay for these water plants.

Of course the original and present cost is easily found by the correspondence, but the difficult thing is to find the depreciation, and this is a matter that no living person can accurately tell. It is simply a matter of opinion and judgment.

Take the important matter of the life of cast iron pipes, you find in New York City pipes that were laid prior to 1842 that are not coated and yet are in almost as good condition as some of the modern coated pipe. These pipes were made of imported Scotch pig and are 70 years old and still in service. The speaker's first assumption as to the life of pipe was an average of one hundred years. We have pipes along the river front that will not last thirty years. The chief engineer of the Board of Estimate and Apportionment limited the life to seventy-five years; the five superintendents referred to all thought one hundred years was fair; but they all considered that seventy-five years was not a fair assumption.

¹ Printed in Vol. 2, No. 1, March, 1915, *Journal*, at pp. 25, etc.

Now with reference to the item of steam pumps, a steam pump that is kept in good order and has been in service perhaps only three or four years, is, usually, in better condition than the day it was first installed. The way we finally figured that was to allow no depreciation for five years where the engine had been in moderate use and kept in prime condition, and thereafter to make a depreciation of 3 per cent per annum, placing the life of the pump at 38 years. Now those steam engines have been in service over seventy years in certain cases; but when you take the element of obsolescence into account it is a very grave question whether it would not have been better to have replaced the pumps long ago.

Then comes the question of the life of a hydrant. Of course we all know that hydrants have been made that remained in service forty years; but we finally arrived at a fair average of twenty-five years.

And so on down the line. These figures are not the judgment of the speaker alone, but were made in coöperation with those other men.

The value of every size of pipe from 4 inches to 36 inches was taken into consideration, and it might be interesting to add a little synopsis of those figures. It is a matter of opinion, and of course all will not agree. The value of a man's opinion is based upon his experience. However, it may be stated that those companies were very well satisfied with the general result. The president of the largest company, after having had two other estimates made, found that they varied only 1 per cent. The city did not intend to pay for those things now and was not trying to cut down every item, but was trying to arrive at a fair valuation for everything from a steam gauge to a 10,000,000 gallon pump, to put a fair value on it and include a fair depreciation. Mr. Wagner's paper gives the general principles on which this is done very admirably. This question of reproduction value, of course, is only one of the things that the company must consider. They must consider the original cost and the market value on the books and submit to the Court the different ways of looking at it. The final judgment, of course, rests with the Court. It would be interesting to hear what some of the members here think about the average life of pipe and the life of steam pumps in ordinary practice.

MR. JOHN M. DIVEN: In the opinion of the speaker the hydrants that were put upon the market over forty years ago are doing as

good service now as they ever did. In Troy we have pipe that was laid in 1833, over 80 years ago. We had occasion to make a six-inch tap on one of these old pipes, and found it to be in good condition and its carrying capacity very little curtailed by age. As to pumping machinery, it is doubtful if a pump is ever worn out, because almost always its capacity is outgrown before it wears out. The speaker does not recall any pump that was ever thrown out because it was worn out, but knows hundreds that were thrown out because their capacity was exceeded.

MR. WILLIAM H. HENBY: Will Mr. Wegmann please state in regard to the acquisition of these plants what consideration was given to private rights of way that have been secured by a holding company, private rights of way or easements that have been acquired.

MR. EDWARD WEGMANN: That question has been raised and the value of the real estate determined by the comptroller of the city of New York, in a case in which the speaker was concerned. The only thing that we were asked to figure on was the physical plant. That question was not brought up by any superintendent, and in fact our tendency was to rather make the estimate large than small, so as to cover omissions that would be brought up in the final taking over of the plant. New York is going to pay for those works, but at the final finding items will be brought up that we overlooked, but everything almost that you could name in the line of water works, from a pressure gauge to a 10,000,000 gallon pump is included in that estimate.